UNION SWITCH & SIGNAL

645 Russell Street
Batesburg, SC 29006

SERVICE MANUAL 7066

Digitair® Model 6695-CC

End-of-Train Sense & Brake Unit (SBU) Composite Case

- Shop Maintenance & Diagnostics
- Circuit Description
- Alignment, Troubleshooting, & Repair
- Parts Lists & Drawings

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1.0 FAMILY OF MANUALS

This is one of two Service Manuals for the DIGITAIR® End-of-Train Model 6695-CC Sense and Brake Unit (SBU). To differentiate the Composite Case (CC) style SBU from US&S' similar aluminum style unit, this manual refers to the SBU as the Model 6695-CC. The complete family of manuals includes:

SM 7065 DIGITAIR® Model 6695-CC Installation & Operation

SM 7066 DIGITAIR® Model 6695-CC Shop Maintenance (this manual)

1.1 DEFINITION OF TERMS

The following terms and abbreviations are used throughout this manual:

EOT - End-of-Train:Refers to an End-of-Train telemetry system comprised of a Cab Unit mounted in the locomotive and an End Unit mounted on the coupler of the last train car.

SBU - Sense and Brake Unit: A two-way End-of-Train End Unit capable of remote Emergency Brake Application, such as the SBU Model 6695-CC.

CDU - Communication Display Unit: Any generic, two-way End-of-Train Cab Unit.

HVM - Highly Visible Marker Device: The Marker Light portion of the SBU: an FRA approved flashing light used as a warning device to mark the end of the train.

1.2 SBU MESSAGE PROTOCOL COMPATIBILITY

The SBU Model 6695-CC is compatible with all EOT equipment employing existing protocols such as the American Association of Railroads (AAR) End-of-Train message protocol. It meets or exceeds the guidelines of the AAR along with the Federal Railroad Administration (FRA), the Federal Communications Commission (FCC), and Industry Canada (IC) regulations.

1.3 R.A.I.L. TEAM AND TECHNICAL SUPPORT

The *Rapid Action Information Link (R.A.I.L.) Team* is comprised of experienced product and application engineers ready to assist and resolve any technical issues concerning DIGITAIR® End-of-Train equipment or any US&S product.

Any questions regarding the contents of this Service Manual should be directed to the R.A.I.L. Team via telephone at 1-800-652-7276 or via Internet e-mail at: ***railteam@switch.com***.

1.4 INTRODUCTION AND GENERAL OVERVIEW

The DIGITAIR® End-of-Train Telemetry System consists of a Sense and Brake Unit (SBU) mounted on the coupler of the last train car that communicates via UHF radio with a Cab Unit, such as the DIGITAIR® Model 6696 Communication Display Unit (CDU), mounted in the locomotive cab.

The SBU, when operating in conjunction with a Cab Unit, provides the locomotive operator with information about the conditions at the rear of the train that are important to the operation of the train, as depicted in Figure 1-1 below.

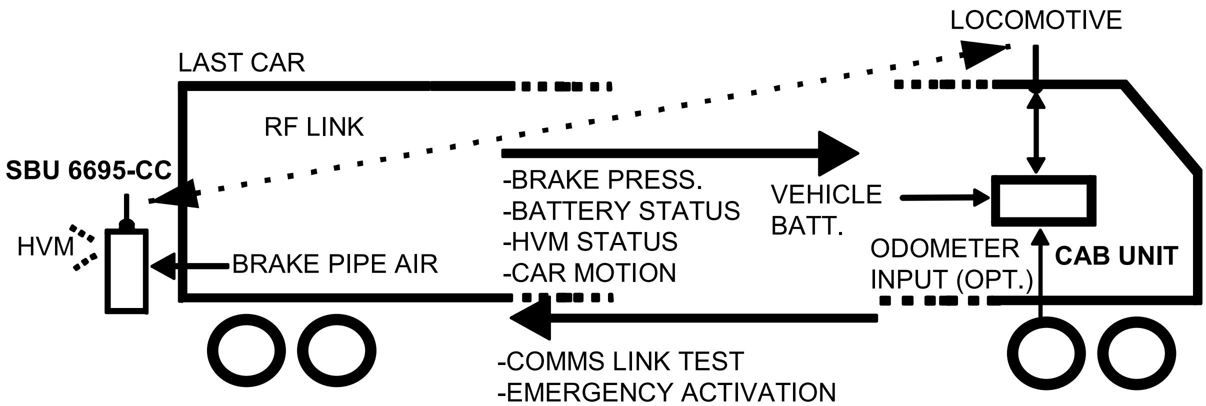


Figure 1-1 - Two-Way End-of-Train Telemetry Functions

This Service Manual provides information on the SBU Model 6695-CC as follows:

- Functional Description and Specifications
- Ordering Information and Service Equipment Options
- Test Equipment Requirements and Built-in Test Modes for Troubleshooting & Repair
- Mechanical Inspection and Disassembly/Reassembly Instructions
- Operation of the Diagnostic Unit Software
- Detailed Circuit Description
- Periodic Maintenance Checks and Services
- Mechanical and Electrical Drawings with associated Parts Lists
- Procedure for Making SINAD Measurements to Verify the Receiver Sensitivity

1.5 SBU MODEL 6696-CC HARDWARE FEATURES

The photo below highlights the SBU Model 6695-CC typical external components. The Exhaust Valve and Air Hose are available in other configurations to accommodate specific requirements.

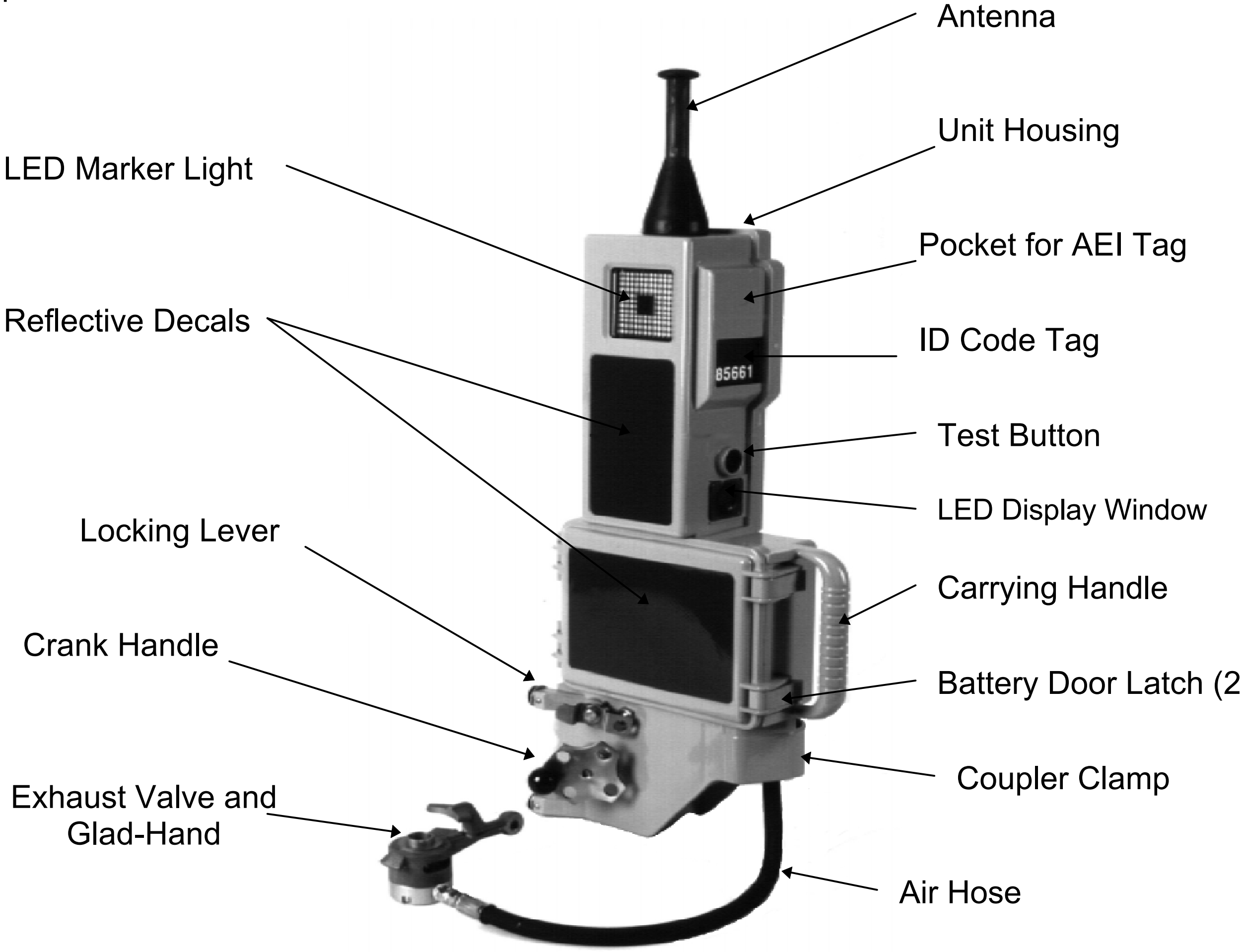


Figure 1-2 - SBU Model 6695-CC

1.5.1 SBU Composite Case

The SBU Model 6695-CC features a molded case manufactured using the latest composite materials. This provides the strength and durability required to protect the internal electronics and related components from the severe environment encountered in the field, such as temperature, vibration, impact, and handling abuse. The latest technology in RF shielded gasket material gives the SBU a high degree of water resistance and RF shielding. A water-resistant conformal coating is applied to all Printed Circuit Boards (PCBs) along with gold-plated connectors for additional protection.

The Model 6695-CC SBU is designed to be lightweight with enhanced balance and a large handle for ease of hand carrying. The unit features highly-reflective 3M™ Diamond Grade reflective tape on the trailing side to increase night visibility for approaching train crews.

The unit also features a conveniently located battery compartment door on its reflector side. Within the battery compartment is an RS-232 serial diagnostics port that connects to a PC. This allows technicians to configure, diagnose, and calibrate the unit without opening its main electronics case.

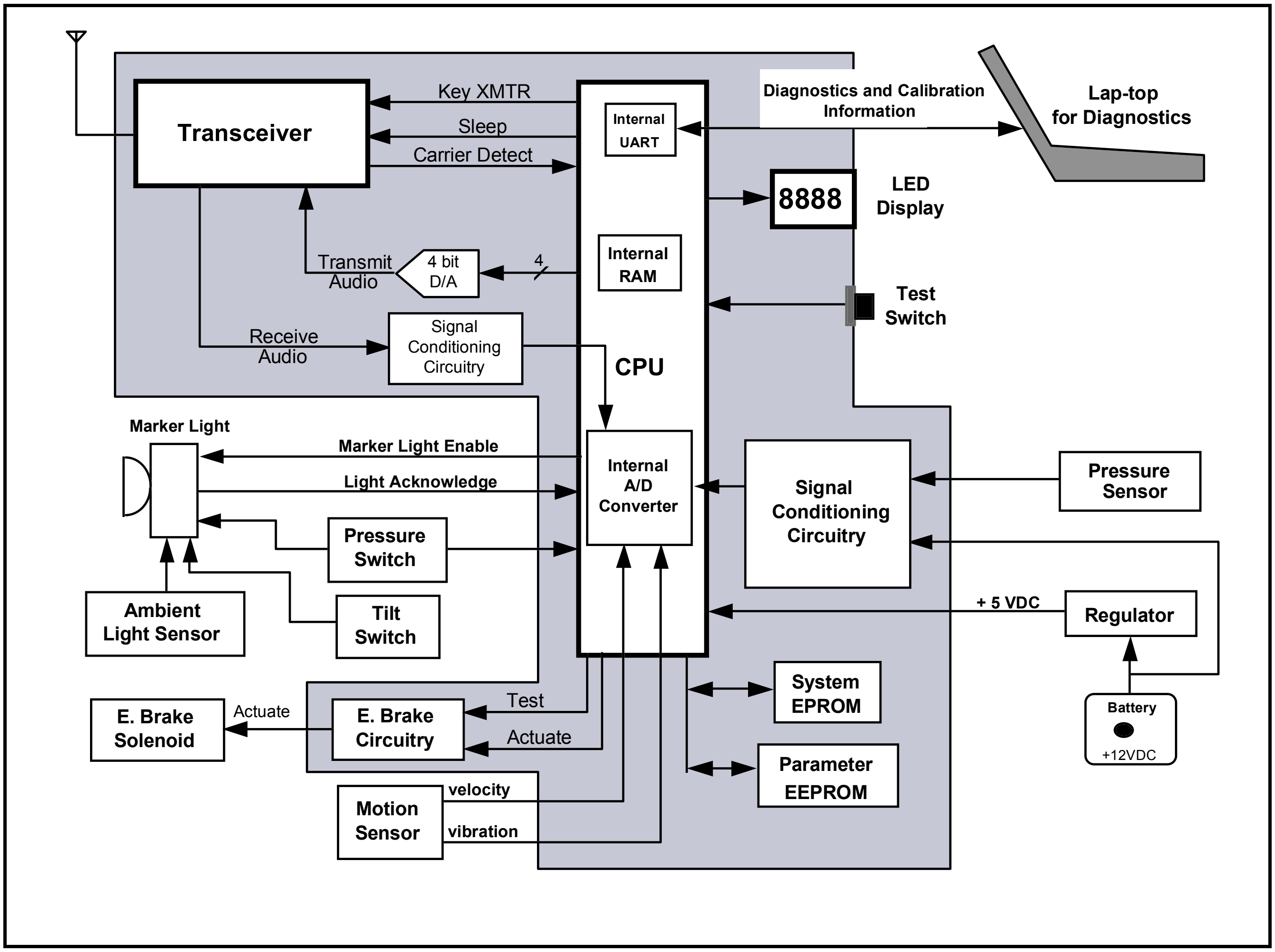


Figure 1-3 - DIGITAIR® SBU Typical Block Diagram

1.5.2 SBU Operating Features and Functions

The SBU, when operating in conjunction with a Cab Unit, provides the locomotive operator with:

- A digital display of the brake pipe pressure at the rear of the train.
- The ability to apply an emergency brake from the rear of the train.
- An indication of motion of the last car (moving/stopped) and the initial direction of motion of the last car on start.
- SBU battery status (weak or replace).
- Warnings about the brake pipe pressure threshold.
- If a Highly Visible Marker (HVM) Light is fitted on the SBU, its on/off flashing status is displayed.
- Radio communications status.

1.6 SBU FUNCTIONAL DESCRIPTION

The SBU mounts on the coupler of the last car of the train and is powered by: 1) up to two Nickel Cadmium (NiCad) type batteries or 2) a single Lead Acid-type battery. The SBU connects to the train's air brake system via an AAR standard "Glad-hand." The SBU transmits data to the Cab Unit using a nominal 2-Watt radio transceiver typically transmitting at 457.9375 MHz and receives commands from the Cab Unit at 452.9375 MHz. These frequencies are standard for North American railroad operations; however, the SBU is available for operation at other UHF frequencies.

The SBU air-sensing system incorporates a pressure transducer designed to be accurate to ±1 psig (±6.895 kpa). To conserve battery life, the SBU automatically powers itself down when the brake line pressure is 5 psig (34 kpa) or less for 5 minutes. Power is automatically restored when the pressure rises above approximately 10 psig (69 kpa).

The Dual Pressure type SBU is fitted with an additional pressure transducer and air hose/glad-hand. This provides for monitoring of an additional air pressure source other than the main brake pipe.

Each SBU is factory coded with a unique five-digit identification number contained in non-volatile, electrically erasable PROM (EEPROM). This ID number is included in each transmitted report so that the Cab Unit can disregard reports from SBUs on nearby trains. Similarly, the Cab Unit includes the ID code in its transmissions so that only the matching SBU will respond.

The SBU measures the pressure and status inputs once per second. It transmits a report approximately once per minute when the pressure and status inputs are steady, and more frequently when any of the following parameters change. Each report is approximately 0.25 seconds in duration. The conditions monitored by the SBU include:

- HVM light on/off state
- Battery condition
- Motion detector state
- Emergency valve circuit state
- No air state (no air pressure for more than the default value of 5 minutes)

In addition to measuring and transmitting pressure and status information, the SBU "listens" for commands from the Cab Unit 3 times per second. If it receives an emergency brake application command, the SBU vents the brake line by activating its emergency brake exhaust valve.

Various test modes are incorporated into the SBU. Of major importance is the external TEST button, and the associated four-character LED display. When the test button is pressed and held, the display shows the following functions. The operation selected is determined by the function displayed when the button is released.

- PRESSURE - Displays the current brake pressure for 30 seconds (default time setting)
- ARM - Although displayed, the Arming Process can be initiated at any time
- TEST - Displays the customer identification string, the software version number, the battery condition, the results of self-test, the brake line pressure, causes a Marker Light self-test and sends a status report to the Cab Unit.
- PHOTOCELL - Blanks the LED display to permit an operator test of the Marker Light

1.7 CAB UNIT GENERAL DESCRIPTION AND CONSIDERATIONS

The SBU may be used with any AAR compatible Cab Unit to display the status at the rear of the train to the locomotive crew. All of the various Cab Units are similar in that they mount in the locomotive cab, connect to an antenna mounted on the roof, derive DC power from the locomotive, receive and transmit data to/from the SBU via UHF radio.

For information on the various US&S DIGITAIR® Cab Units compatible with the Model 6695-CC SBU, consult the following manuals:

SM-7042	Models 6652 CLU/Model 6653 IDU Operator's Guide
SM-7050	Models 6656, 6656A CDU Installation and Operator's Guide
SM-7050A	Models 6656, 6656A CDU Shop Maintenance
SM-7063	Model 6696 CDU Installation and Operation
SM-7064	Model 6696 CDU Shop Maintenance

1.8 ORDERING INFORMATION

Refer to Service Manual SM 7065, Section 1.5 for ordering information regarding the various features, options, and mechanical configurations available for the SBU Model 6695-CC.

1.9 DIAGNOSTIC SOFTWARE DISKETTE

The SBU does not rely on a dedicated external device for system diagnostics and configuration. All of the unit diagnostic tests and configuration functions are included on a diskette that runs on a standard DOS-compatible personal computer (PC). The PC plugs into the SBU's Diagnostic Port, located in the battery compartment, via a standard serial cable.

The Diagnostic Software has been designed to permit easy customization of the operation of the SBU. Most of the variable default values and functions are user selectable, set by the factory at purchase time, or by railway technicians via a PC computer. The Diagnostic Software program on the disk is named **"diagunit.exe"** and its use is described in Section 3.0.

The Diagnostic Software Diskette can be ordered under the following part numbers:

Description	Part Number
3.5” Diskette	N451232-1264
5.25” Diskette	N451232-1265

Table 1.1 - Diagnostic Software Diskette

1.10 SBU SPECIFICATIONS

PARAMETER	MIN.	TYPICAL	MAX.	UNITS	NOTE
Environmental					
Operating Temperature Range	-40º	--	+70º	C	--
Storage Temperature Range	-40º	--	+70º	C	--
Humidity @ +50ºC (non-condensing)	--	--	95	%	--
Altitude	--	--	12000/3,660	feet/meters	--
Vibration - Vertical & Lateral (Peak)					
1 - 15 Hz	--	--	0.25	g	--
15-500 Hz	--	--	2.5	g	--
Vibration - Longitudinal (Peak)					
1 - 15 Hz	--	--	1.5	g	--
15-500 Hz	--	--	2.5	g	--
Shock-any axis, peak (half sine wave, 11ms duration)	--	--	10	g	--
Physical					
Housing Dimension (including coupler mount)					
Depth	--	5.0/127	--	in./mm	--
Height (including antenna)	--	37.5/953	--	in./mm	--
Width	--	14.0/356	--	in./mm	--
Weight (standard NiCad type unit)	--	23/10.4	--	lb./kg	--
Power Requirements					
NiCad or Lead Acid Battery					
Operating Voltage Range					
Within Specification	10.5	--	14.0	Vdc	--
Degraded Specification	10.0	--	14.2	Vdc	--
"No Damage" Range	0	--	14.2	Vdc	--
Battery Protection: reverse polarity fuse					
Battery Life (with NiCad Battery)	@ -40C	@ +25C	@ +70C		1
SBU Telemetry with HVM - 1 battery	1.51	3.78	3.78	days	2
SBU Telemetry with HVM - 2 batteries	3.02	7.56	7.56	days	2
Pressure Measurement					
Range - No Damage	--	--	200/1380	psig/kpa	
Range - Operating	0	--	125/860	psig/kpa	
Error (+/-)	--	1	3/20	psig/kpa	
Measurement Interval	--	960	--	msec	--
'Power-On' Threshold	6	7	9/60	psig/kpa	
'Power-Off' Threshold (NO AIR)	-	--	5/35	psig/kpa	

1. NiCad rechargeable - continuous operation. Note: Reported “Weak” and “Replace” times will be less.
2. Values given assume that HVM Light is off 50% of the time, i.e., during the day.

Table 1.2 - SBU Model 6695-CC Specifications

PARAMETER	MIN.	TYPICAL	MAX.	UNITS	NOTE
HVM Strobe Light (FRA approved)					
Color - Red					
Effective Intensity, centerline	100	300	--	Candela	--
Effective Intensity:					
+/- 15° horizontal	50	60	--	Candela	--
+/- 5° vertical	50	60	--	Candela	--
Flash Period	--	1		sec	--
Flash “On” time	--	0.1		sec	--
Motion Detector					
Indications Provided: Stop, Forward, Reverse, Moving					
Reporting Rate					
Pressure change < 2 psig					
-pseudo random timer	55	60	65	sec	--
Pressure change 2 to 4 psig	--	--	5	sec	--
Pressure change 5 psig or more	--	--	2	sec	--
(Reports are also made if 'NO AIR', external status change, motion change or external TEST button pushed)					

Table 1.2 - SBU Model 6695-CC Specifications (continued)

PARAMETER	MIN.	TYPICAL	MAX.	UNITS	NOTE
Radio Transmitter Section					
Frequency Range – UHF (North America – P/N: N24600004) (Australia – P/N: N24600005)	450	 457.9375 450.250	470	MHz	--
Power Output	--	2	--	Watts	--
Frequency Stability (-40°C to +60°C)	--	--	5	ppm	--
Emission	--	16K0F2D	--	--	--
Deviation (transmitting preamble)	2.9	3.0	3.1	KHz	--
Radio Receiver Section					
Frequency Range – UHF (North America – P/N: N24600004) (Australia – P/N: N24600005))	450	 452.9375 450.250	470	MHz	--
Sensitivity: Input req'd for -12 dB SINAD	--	0.25	0.4	uV	--
Frequency Stability (-40°C to +60° C)	--	--	10	ppm	--
Selectivity (+/- 25 KHz)	60	--	--	dB	--
Intermodulation Immunity	60	--	--	dB	--
Spurious Rejection	55	--	--	dB	--
Image Rejection	50	--	--	dB	--

Table 1.3 - Transceiver Specifications

(SBU Equipped With Motorola RNET 450 Transceiver)

PARAMETER	MIN.	TYPICAL	MAX.	UNITS	NOTE
Radio Transmitter Section					
Frequency Range - UHF	450		480	MHz	--
(North America – P/N: N24600007)		457.9375			
(Australia – P/N: N24600009)		477.700			
(Finland – P/N: N24600010)		457.650			
(Argentina – P/N: N24600011)		458.075			
Power Output	--	2	--	Watts	--
Frequency Stability (-40°C to +60°C)	--	--	± 1.5	ppm	--
Emission	--	16K0F2D	--	--	--
Spurious and Harmonic FM	--	-37	--	dBm	
Deviation (transmitting preamble)				KHz	--
- North America	2.9	3.0	3.1		
- Australia	1.9	2.0	2.1		
- Finland	2.9	3.0	3.1		
- Argentina	2.9	3.0	3.1		
Radio Receiver Section					
Frequency Range - UHF	450		480	MHz	--
(North America)		452.9375			
(Australia)		472.500			
(Finland)		467.650			
(Argentina)		458.075			
Sensitivity: Input req'd for -12 dB SINAD	--	0.25	0.4	uV	--
Frequency Stability (-40°C to +60° C)	--	--	± 1.5	ppm	--
Selectivity (+/- 25 KHz)	70	--	--	dB	--
Intermodulation Immunity	70	--	--	dB	--
Spurious and Image Rejection	70	--	--	dB	--

Table 1.4 - Transceiver Specifications
(SBU Equipped With Johnson Data Telemetry Transceiver)

PARAMETER	MIN.	TYPICAL	MAX.	UNITS	NOTE
Physical					
Dimensions					
Height	--	2.62/66.5	--	in./mm	--
Length	--	6.58/168	--	in./mm	--
Width	--	2.75/70	--	in./mm	--
Weight	--	--	3.60/1.63	lbs./kg	--
Capacity					
120 ma discharge rate:					
- 20°C	--	4.25	--	Ah	--
+ 25°C	--	5.5	--	Ah	--
Cycling Life					
Capacity After 1000 Cycles	50	--	--	%	1
Miscellaneous					
Mon./Yr. of Manufacture is marked on each battery					

(One cycle = 5 hours discharge at 800 ma to 10.00 Volts after a slow or quick charge.)

Table 1.5 - NiCad Battery Specifications

1.11 LEAD ACID BATTERY SPECIFICATIONS

For specifications on the Lead Acid type battery, please consult the battery vendor’s documentation.

2.0 INTRODUCTION

This section provides a description of the built-in SBU Test Modes and a shop troubleshooting guide to help isolate system faults to the assembly and board level. Information is also included that may enable diagnosis of a number of faults down to the component level.

2.1 TEST EQUIPMENT REQUIREMENTS

To perform detailed troubleshooting and maintenance of the SBU, the following equipment is recommended and/or required:

Item	Description
DIGITAIR CDU with integral display	US&S Model 6696 or equivalent
2 charged DIGITAIR NiCad batteries	US&S Part No. 303-0021-00
Tool kit: regular electronics type	--
Precision voltmeter: 4 digits	Fluke 8600A or equiv.
Oscilloscope: dual channel, 50 MHz	Tektronix 2235 or 2215 or equiv.
Power Supply: 0-15 volts, 3A, fine adjustment	Xantrex 6020D or equiv.
Air supply: 0-85 psig/0-600 kpa Quick-opening valve Glad-hand fitting Volume: At least 1 liter upstream of glad-hand, downstream of regulator. Pressure regulator: Adjustable 0-85 psig/0-600 kpa, setable to 1 psig/6.895 kpa, stable to 0.1 psig/0.690 kpa at no flow	See Figure 2-1
Air tank: 8 to 20 gallon/34 to 340 liter capacity with Glad-hand coupling attached directly to inspection port	See Figure 2-1
Air pressure gauge: 0-200 psig/0-1380 kpa, ±0.5 psig/±3.45 kpa	Setra Model 360 Digital Pressure Gauge
Temperature probe: ± 0.5°C, resolution of 0.1°C room ambient temperature range	Fluke 2175A (Thermocouple J, K, T or E)
RF Thruline Wattmeter: 500 MHz, 5 and 25W elements, with "BNC" style connectors	Bird 43 or equiv.
Dummy load: 10W, 50 ohm	Bird 8052/8053 or equiv.
Communications monitor: Carrier accuracy: Better than ±1 PPM Deviation meter Scope display Receive/transmit capability Sinadder Type "N" RF input/output connector preferred	Motorola R-2600 or equiv.

Table 2.1 - Maintenance Equipment Requirements

2.2 GOVERNMENT LICENSES

Only personnel who have the proper government (FCC) issued licenses may perform adjustments to the radio portion of the equipment.

WARNING

COMPRESSED AIR

WHEN WORKING WITH COMPRESSED AIR MAKE SURE THE AIR SUPPLY IS CLEAN, THE TEST EQUIPMENT IS IN GOOD ORDER AND THE GLAD-HAND IS FULLY ENGAGED BEFORE APPLYING AIR PRESSURE.

ALWAYS PRESS THE PRESSURE RELIEF BUTTON ON THE EMERGENCY VALVE BEFORE DISCONNECTING IT FROM THE GLAD-HAND.

WHEN PERFORMING EMERGENCY BRAKE EXHAUST VALVE TESTS, BEWARE OF THE BLAST FROM THE BOTTOM OF THE VALVE. IF THESE ACTIONS ARE NOT TAKEN, PERSONAL INJURY COULD RESULT.

HIGH VOLTAGE

AVOID PERSONAL CONTACT WHEN UNIT IS POWERED UP. 72V DC POWER INPUT TO CDU IS BEING USED TO SYSTEM TEST THE SBU. THIS LEVEL OF DIRECT CURRENT IS DANGEROUS IF CONTACTED.

2.3 SBU QUICK EXTERNAL TEST

The following is intended as a quick shop test to check out an SBU **without removing its rear panel**. It is to be performed with the equipment stabilized at a room temperature. If any problems are encountered, the SBU will have to be opened and tested more thoroughly. Refer to Section 2.4.

2.3.1 Mechanical Check

The entire SBU should be visually inspected for mechanical damage. In particular, the following items should be checked:

- Unit housing
- Antenna
- External TEST button
- LED display window
- Battery door, hinges, gasket and latches
- Battery holding and locating pins, and retaining nuts
- Mounting clamp
- Frame
- Coupler mounting jaws
- Spindle and spindle handle
- Shaft and shaft retainer
- Rubber "feet"
- Security Locking Latch
- Emergency brake exhaust valve, glad-hand, and hose.

2.3.2 Initial Jumper Settings for Test

NOTE

For SBUs equipped with NiCad type batteries, if the jumper was originally in the lower position (example: between pins 1 and 2, “unshared batteries”), make a note to return it to that position before returning the SBU to service.

To simplify the test procedures, **for SBUs equipped with NiCad type batteries** ensure that the large jumper (J1) on the Interface/Fuse board inside the battery compartment is in the upper position (such as between pins 2 and 3, “shared batteries”). This places the two batteries in parallel so that a single battery may be placed in either position to power both the telemetry and the HVM. For the Lead Acid battery type SBU, leave the jumpers in their default positions.

2.3.3 External Functional Tests

Remove the batteries from the SBU. Insert a charged battery in the telemetry battery compartment. Press and hold the SBU test button until the display reads “TEST” and then release it. The Marker Light will flash for a configured number of seconds (default = 5). The telemetry system will run a self-test, and the following information will be displayed on the SBU four-character LED display:

1. The Customer Identification String, or **“US&S”** by default.

2. The software version number (e.g., **“REV11”**).

3. The battery condition depending on the type of battery as follows:

(A) For the NiCad Battery type SBU, one of the following displays:

“OK##”	Battery is Good, More than 39% of timed charge remaining. (where ## indicates the estimated percentage of battery life remaining)
“LO##”	Low - 12% to 39% of timed charge remaining.
“WEAK”	Weak - Less than 12% of timed charge remaining.
“REPLACE”	Replace - 0% of timed charge remaining.

(B) For the Lead Acid Battery type SBU, one of the following displays:

“GOOD”	Battery is good. Voltage is approximately greater than 11.9 volts.
“WEAK”	Battery is weak. Voltage is approximately between 11.9 and 10.7 volts.
“REPLACE”	Battery needs replacement. Voltage is approximately between 10.6 and 10.0 volts.
“ABORT”	Battery is non-usable. Voltage is less than approximately 9.9 volts.

4. The results of self-test (e.g., **“Self Test GOOD”** or **“Self Test BAD”**)

5. The brake pipe pressure - the display will read:

   “P###” where ### is the brake pressure, in psig

   To further conserve battery capacity, leading zeros are suppressed in the display (for example, “P 85”).

6. When the TEST button is released, a status report is transmitted to the Cab Unit.

7. If a communications monitor is available, connect a small whip antenna to the antenna input of the monitor and set the monitor to check the transmitter frequency, 457.9375 (477.700) MHz. The transmitter frequency error should be ± 2.29 KHz.

2.3.4 Communications

1. Insert a charged battery into the SBU. For bench testing, it is recommended that a 50-ohm dummy load be connected to the Cab Unit antenna connector. RF leakage is sufficient at this range for good two-way communication, if the equipment is working properly.

2. Power-up the Cab Unit.

3. To ensure that it is not armed, enter an ID of 00000 or use the Disarm function. Then enter the ID of the SBU under test.

4. The Cab Unit should indicate a “Not Armed” condition.

2.3.5 Communications Test

1. Press and hold the SBU TEST button until the display reads “TEST” and then release it, as in the previous section. Since no pressure is applied to the SBU, the Cab Unit should indicate 0 psig/kpa.

2. Press the Comm/Arm button on the Cab Unit. The SBU should respond with a status update in approximately one (1) second.

3. Confirm that the Cab Unit indicates a successful Comm Test.

2.3.6 Arming Check

1. Press the SBU TEST button. A “Request to Arm” signal is sent by the SBU.

2. When the Cab Unit receives the "Request to Arm" message, it will indicate “Arm Now.” Within five (5) seconds, press the COMMUNICATIONS TEST button to initiate a "Command to Arm" message.

   If the SBU receives the "Command to Arm" message within six (6) seconds of its initial arming message, it responds with an "Arming Confirmation" message (a normal status report complete with pressure reading, with the confirmation bit set).

   When the Cab Unit receives the "Arming Confirmation" message, the arming process is a success.

3. Observe that the Cab Unit indicates a successful arming sequence.

2.3.7 Emergency Brake Application

WARNING

USE SAFETY GLASSES AND EAR PLUGS WHEN PERFORMING THIS PROCEDURE, OTHERWISE PERSONAL INJURY MAY RESULT!

1. Refer to Figure 2-1 below for Test Equipment Setup.

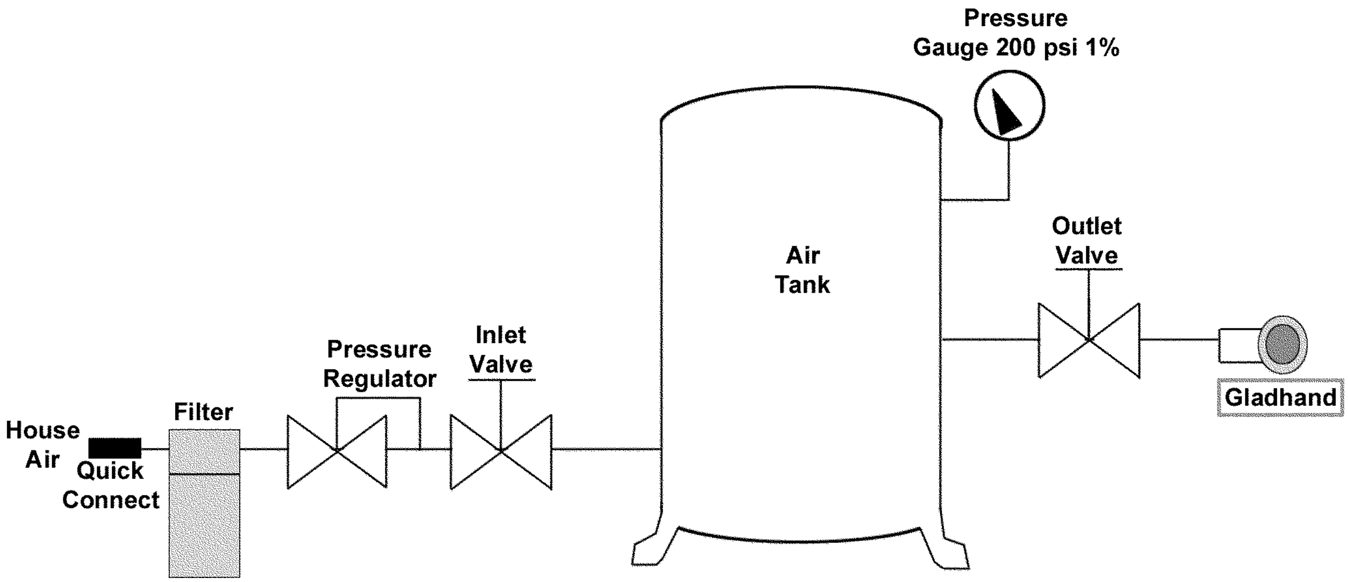


Figure 2-1 – Emergency Brake Test Equipment Setup

2. Connect the air tank to the SBU glad-hand. Pressurize the tank to 85 psig and close the line to the air supply. The Cab Unit should indicate this pressure within ± 2 psig.

3. Activate the Emergency Switch on the CDU.

4. The solenoid valve/exhaust valve in the SBU should open within approximately one (1) second. A loud blast of air should be heard and the air tank should empty within five (5) seconds. The Cab Unit should display 0 psig.

5. After a configurable period of time (default = 45 seconds), the valve should close with an audible “click.” In the case where the SBU is configured for “Set Brake Valve Open Duration” a equal to zero seconds, the solenoid valve will remain open indefinitely until the TEST push-button is pressed.

2.3.8 Marker Light (HVM)

1. Press and hold the TEST button on the SBU until the display reads “PHOTOCELL” (the SBU will display “PRESSURE,” “ARM,” and “TEST” before indicating “PHOTOCELL”), then release the button. The display will become dark for the operator to check the photocell light sensor for proper operation.

2. If the ambient light level is relatively high due to bright lights or sunlight, cover the light sensor located inside the display window to ensure that the Marker Light begins to flash. The CDU should indicate “HVM On” or “MARKER On.” Uncovering the sensor again should cause the Marker Light to stop flashing. The CDU should indicate that the Marker Light has turned off.

3. If the ambient light level is low, the Marker Light should already be flashing. To test a sensor in this condition, shine a light on the display window. The Marker Light should stop flashing and the CDU should indicate that the Marker Light is off. When the light is removed, the Marker Light should begin flashing again.

4. Press and hold the TEST button on the SBU until the display reads “TEST,” then release the button. The Marker Light should flash for the configured number of times and the SBU should run through the self-test.

2.3.9 Tilt Switch Operation

The Marker Light is equipped with a tilt switch to ensure that the Marker Light does not continue to run after the SBU is removed from the train and laid down. If pressure is present, the tilt switch <u>will</u> <u>not</u> turn off the Marker Light.

1. Apply at least 10 psig to the SBU.

2. Press and hold the SBU test button until the display reads “TEST” and then release it. The Marker Light should flash briefly. Immediately after the SBU display goes dark, cover the photocell (located behind the display window). The Marker Light should begin flashing.

3. Tip the SBU over <u>at</u> <u>least</u> 50°. The Marker Light should continue to flash. Return the SBU to the vertical position. Reduce the pressure to 0 psig.

4. Tip the SBU over <u>at</u> <u>least</u> 50°. The Marker Light should stop flashing. Returning the SBU to the vertical position should not cause the Marker Light to begin flashing.

2.3.10 Pressure Power Up

1. Wait 5 minutes for the SBU to power down as a result of having zero air pressure. Set the output of the air source to 0 psig. Connect the air source to the glad-hand.

2. Apply 10 psig to the SBU air line. The SBU should power up, the Marker Light should flash for a configured number of seconds (default = 5), the telemetry system will run a self-test, and the standard test information will be displayed on the SBU. The pressure should indicate 10 psig on the SBU display and also on the CDU.

3. Apply known air pressures to cover the rest of the desired measurement range (e.g., 20, 45, and 85 psig.) In each case, verify that the CDU displays correct air pressure to within ± 2 psig.

2.3.11 Zero Pressure Shutdown

Set the output of the air source to 0 psig. The SBU should power down after approximately five (5) minutes as a result of having zero air pressure.

2.3.12 Motion Detector

Set the pressure to approximately 50 psig (the exact value is not critical). Leave the SBU motionless for a minute to ensure that the motion detector is fully at rest. Ensure that the Cab Unit indicates no motion or “stopped.”

NOTE

High ambient vibration (shaking floors, etc.) will give poor results in the following motion tests. If necessary, steps should be taken to isolate the SBU from the vibration.

2.3.13 Check Forward Motion

1. Move the SBU sharply forward (i.e. in the direction it would move on a forward-moving train) and then gently rock the unit to simulate continued train movement.

2. The Cab Unit display should indicate “Forward”. After about 20 seconds the Cab Unit display should indicate “Moving.”

3. Hold the SBU motionless. After a few seconds, the CDU display should indicate “Stopped.”

2.3.14 Check Reverse Motion

1. Move the SBU sharply backwards (i.e., in the direction it would move on a backward-moving train) and then gently rock the unit to simulate continued train movement.

2. The CDU display should indicate “Reverse.” After about 20 seconds the CDU display should indicate “Moving.”

3. Hold the SBU Unit motionless. After a few seconds, the CDU display should indicate “Stopped.”

If the display indications were not correct, repeat to verify the failed indication. It could be that the train’s movements were not simulated correctly, or that transmissions were corrupted by transmissions from other SBUs.

2.3.15 Battery Sensing

1. Preset the variable voltage power supply to 12.5 volts and turn it off.

2. Remove the battery or batteries from the SBU. Using clip leads, connect the variable voltage power supply to the SBU’s battery contacts. Be careful to observe the polarity when connecting the leads.

3. Turn on the power supply.
4. Press and hold the SBU TEST button until the display reads “TEST” and then release it. The Marker Light should flash and the SBU LED display should display the standard self-test messages. The CDU should indicate 0 psig.
5. After the SBU display goes dark, begin slowly reducing the supply voltage.
6. When the supply voltage reaches approximately 11.40 VDC, the CDU should indicate a WEAK Battery condition. Continue reducing the supply voltage slowly.
7. When the supply voltage reaches approximately 10.50 VDC, the CDU should indicate a REPLACE Battery condition.

2.4 SBU MECHANICAL INSPECTION

Prior to performing shop maintenance on the SBU, visually inspect the unit for mechanical damage. Refer to Section 2.3.1 for details.

2.4.1 Torque Requirements for Composite Case Fasteners

The composite case utilizes special threaded inserts for fastening the rear cover to the main housing and to mount the various electronic and mechanical assemblies comprising the unit. When tightening the associated fasteners, **observe and adhere to the following torque requirements**:

Assembly	Torque Specification	Fastener Information
Back Panel	12 in-lbs	10-32 Allen Head Screws
Interface/Fuse Board	4 in-lbs	4-40 Slotted Head Screws
NiCad Battery Holding Post	46 in-lbs	1/4 - 28 Threaded Post
HVM Light Lens	6 in-lbs	6-32 Slotted Head Screws
Telemetry Compartment	8 in-lbs	6-32 Slotted Head Screws
Coupler Jaw Shaft Retainer Bar	41 in-lbs	8-32 Allen Head Screws

Table 2.2 - Torque Requirements for Composite Case SBU

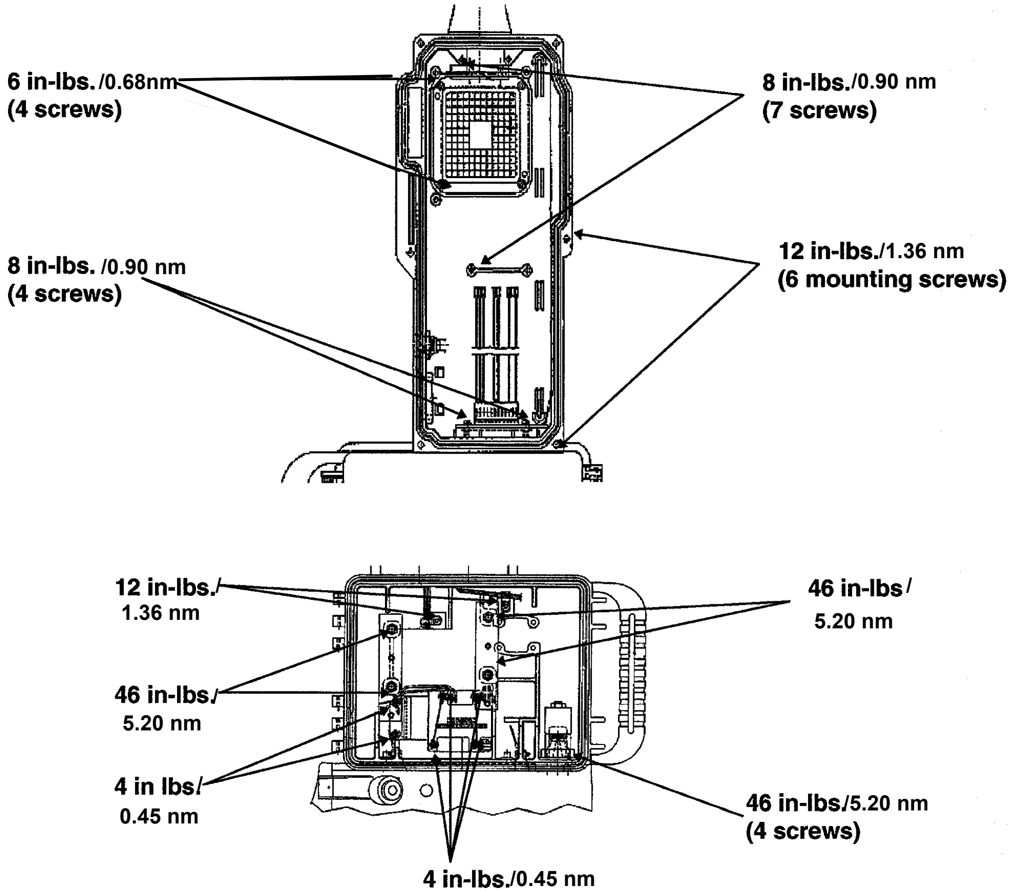


Figure 2-2 - Torque Requirements for Back Panel and Electronic/Mechanical Assemblies

2.5 SBU DISASSEMBLY AND REASSEMBLY PROCEDURES

While performing the following procedures, please refer to the parts lists and drawings provided in Appendix A.

CAUTION

The SBU contains static sensitive components. Always work at a grounded workstation and observe proper ESD handling practices. Uninstalled circuit boards must always be contained in static-free bags. If these procedures are not followed, equipment damage may result.

NOTE

When tightening the various screws used for each assembly, follow the torque requirements for each as stated Section 2.4.1. Over torquing the screws can cause the inserts to pull out.

WARNING

DO NOT APPLY THREADLOCKER (LOCTITE) TO ANY OF THE SCREWS WHEN TIGHTENING THEM. THE CHEMISTRY OF THE THREADLOCKER CAN CAUSE OUTGASSING AND WILL ATTACK THE COMPOSITE MATERIAL MAKING IT BRITTLE. THREADLOCKER IS NOT REQUIRED AS ALL SCREWS EITHER HAVE A LOCKWASHER OR ARE SECURED BY TENSION.

2.5.1 Removing the Rear Panel

1. Remove the battery or batteries from the SBU.
2. Using a 5/32" Allen wrench, remove the six (6) hexhead capscrews in the rear panel. Carefully lift off the rear panel.
3. Carefully inspect the rear panel gasket for damage. If damage is noted, replace the gasket before re-installing the rear panel.

NOTE

In SBUs equipped for secondary air pressure measurement, an additional air hose is fitted to the rear panel. When removing the panel, unplug the auxiliary pressure transducer connector from the SBU processor board.

2.5.2 Removing the Electronics Cage Assembly

1. Disconnect the Antenna coaxial cable BNC connector from the radio transceiver module.
2. Disconnect the ribbon cable connector from the processor board and bend it out of the way.
3. Remove the four (4) (five (5) for the Dual Pressure type SBU) push-on connectors located along the back edge of the processor PC board. These connectors are associated with:

- The pressure switch
- The pressure transducer(s)
- The emergency brake valve solenoid
- The test button

Locate the 7 electronics cage mounting screws:

- two (2) near the base of the antenna
- one (1) in the upper left-hand corner of the Marker Light PC board
- one (1) in the upper right-hand corner of the Marker Light PC board
- one (1) above and slightly to the left of the radio
- two (2) along the bottom edge of the Marker Light PC board

Remove the seven (7) machine screws, making sure to locate, remove, and save all washers and lockwashers.

2.5.3 Removing the Radio Transceiver Module

NOTE

Depending on the length of the screwdriver blade, it may be easier to first remove the Motion Detector.

1. Remove the Electronics Cage Assembly, as described Section 2.5.2.
2. Remove the two (2) 4-40 machine screws retaining the 15 pin “D” connector and remove the connector.
3. Remove the four (4) 2-56 machine screws securing the radio, and make sure to locate, remove and save all washers and lockwashers. Lift out the radio.

2.5.4 Removing the Motion Detector

1. Remove the Electronics Cage Assembly, as described Section 2.4.3.
2. Unplug the 10-pin Motion Detector ribbon cable connector from the processor board.
3. Remove the 6-32 machine screws and washers securing the Motion Detector and lift it out.

2.5.5 Removing the Air Manifold Assembly

1. Unplug the push-on connectors associated with the components on the Air Manifold Assembly. These connectors are associated with:
   - The pressure switch
   - The pressure transducer
   - The emergency brake valve solenoid
2. Remove the SBU air hose or In-Line Exhaust Valve located at the bottom underside of the SBU. Note that the hose has a swivel fitting. Be sure to grip the end-most hex portion of the fitting.
3. Using a 5/32” Allen wrench, loosen and remove the four hexhead capscrews and washers securing retaining the Air Manifold Assembly. Now the Air Manifold and its gasket can be removed.

2.5.6 SBU Reassembly

NOTE

When tightening the various screws used for each assembly, follow the torque requirements for each as stated Section 2.4.1. Over torquing the screws can cause the inserts to pull out.

WARNING

DO NOT APPLY THREADLOCKER (LOCTITE) TO ANY OF THE SCREWS WHEN TIGHTENING THEM. THE CHEMISTRY OF THE THREADLOCKER CAN CAUSE OUTGASSING AND WILL ATTACK THE COMPOSITE MATERIAL MAKING IT BRITTLE. THREADLOCKER IS NOT REQUIRED AS ALL SCREWS EITHER HAVE A LOCKWASHER OR ARE SECURED BY TENSION.

2.5.7 Reinstalling the Pressure Manifold

1. Place the gasket and manifold in the bottom of the battery compartment with the solenoid facing towards the open end.

2. Replace the four (4) hexhead capscrews and lockwashers. Tighten with a 5/32” Allen wrench.

3. Install the air hose or the in-line exhaust valve using a pipe sealant (US&S J041753, Loctite 56747 or equivalent). Be sure to grip the end-most hex portion of the fitting when tightening.

2.5.8 Reinstalling the Radio

1. Place the radio into the mounting slot in the electronics cage.

2. Secure the radio with the four (4) 2-56 machine screws. Use a washer and lockwasher with each screw.

3. Replace the 15-pin “D” connector and secure it with the two (2) 4-40 screws.

2.5.9 Reinstalling the Motion Detector

1. Place the Motion Detector in the electronics cage making sure that the ribbon cable is facing toward the open end of the enclosure.

2. Secure the Motion Detector with 6-32 machine screws. Use a washer and lockwasher with each screw.

3. Reconnect the 10-pin Motion Detector ribbon cable connector to J4 on the processor board.

2.5.10 Reinstalling the Electronics Cage

1. Ease the electronics cage into position, tucking the top end behind the base of the antenna.

2. Secure the electronics cage with seven (7) 6-32 machine screws:

   - two near the base of the antenna
   - one in the upper left-hand corner of the Marker Light PC board
   - one in the upper right-hand corner of the Marker Light PC board
   - one above and slightly to the left of the radio
   - two along the bottom edge of the Marker Light PC board.

Be certain to use a washer and lockwasher with each screw.

NOTE

- **If the SBU is equipped with slotted type screws to secure the electronics cage, use a “leaf-spring” type locking screwdriver (e.g., ChanneLock model 77H) to ease the installation of the screw/washer/lockwasher combination.**
- **In Dual-pressure SBUs, pay particular attention to the placement of connectors J9 and J10. These two connectors are not keyed and could be interchanged.**

3. Replace the push-on connectors located along the back edge of the microcontroller PC board. When properly installed, the wires on all connectors should extend towards the opening of the SBU.

   From bottom to top, the connectors are:

   - The emergency brake valve solenoid - J12
   - The pressure switch - J11
   - The pressure transducer - J10
   - The secondary pressure transducer (if present) - J9
   - The test button - J8

2.5.11 Reinstalling the Rear Panel

1. Carefully reinstall the rear panel, ensuring that the card guides line up with the ends of the processor board. ***Do not force it into place***. If the SBU is a dual pressure type unit, first plug the auxiliary pressure transducer connector onto J9 on the processor board.

2. Replace the six (6) hexhead capscrews in the rear panel. Using a 5/32" Allen wrench, tighten them uniformly, alternating back and forth from top to bottom and side to side.

CAUTION

Do NOT apply threadlocker (LOCTITE) to the screws when securing the rear panel. This will case the composite material to become brittle and prone to breakage.

NOTE

Torque the six screws to 12 in-lbs/1.36 nm MAXIMUM. Over torquing these screws can cause the inserts to pull out.

2.5.12 Retesting

After reassembly, test the SBU as stated in Section 2.3, Quick External Tests.

2.6 CHECKS AND TESTS OF THE MAJOR SBU ASSEMBLIES

For the following checks and tests, disassemble/reassemble the SBU as required per the procedures described above in Section 2.5. Also refer to the parts lists and drawings in Appendix A.

2.6.1 Testing the Air Manifold Assembly for Leaks

Inspect the Air Manifold Assembly for the following:

- External damage
- Particles obstructing the exhaust hole
- The nut on top of the solenoid valve is secure
- The seal around the Pressure Switch and Transducer

1. Remove and clean the screen or replace if clogged.

2. Apply 85 psig air pressure to the Air Manifold Assembly via the air line connection and then close the air supply valve.

3. Listen for air leaks. If an air leak is suspected at a certain component, apply soapy water to the area in question and watch for bubbles. If leaks are found, release the air pressure. Tighten and/or reseal around the suspected component and retest.

2.6.2 Functional Check of the Motion Detector

The SBU will be equipped with one of two types of Motion Detectors as follows:

- Old-Style Crystal Pendulum Motion Detector (P/N: N451873-8001)
- New-Style Solid State Motion Detector (P/N: N24610101)

2.6.2.1 Functional Check of Old-Style Crystal Pendulum Motion Detector

The motion detector is an accelerometer that detects the various forces acting on the SBU. It has two outputs: vibration and velocity. The latter is a composite of two signal processing functions in the hardware of the Motion Detector: an integrator and an impulse detector. The vibration output is a DC level that decreases with increasing vibration. The motion status is interpreted from the two signals by the microcontroller.

To perform a functional test of the motion detector, the SBU must be held vertically. The following steps examine the raw output of the motion detector and are given to provide confirmation and a diagnosis of problems seen in the External Test described in Section 2.3.12.

1. Place the SBU in a vertical position so that the motion detector is in its normal operating orientation and hold the enclosure so it remains motionless.

NOTE

High ambient vibration (shaking floors, etc.) will give poor results in the following motion tests. If this becomes a problem, steps should be taken to isolate the SBU from the vibration.

2. Observe pins 6 and 8 of J4 on the Microcontroller board with an oscilloscope (sweep speed of 0.5 seconds per division).
3. Observe the waveform on pin 6 (velocity or motion). It should be a constant value between 2.4 and 2.7 volts. After ten (10) seconds, the motion detector's internal reset relay will be released. Observe that the waveform has a momentary increase about once per second after release of the relay and that it remains at about the same level.
4. Check the waveform on pin 8 (vibration). It should also have the periodic increase and should be greater than 4.4 volts (during the increase) while the motion detector is motionless.
5. Now gently tilt the SBU. Check the waveform on pin 6. Its trace on the scope should smoothly change to a new value; the once-per-second momentary increase should still be observed. If the waveform jumps to +5V or 0V, the motion was too rough and the impulse sensor in the motion detector was triggered; try again after waiting until the motion detector relay activates (on Stop) and releases 2 seconds later.
6. If the waveform on pin 6 is jagged, the motion detector crystal is fractured; in this case, return the motion detector to US&S for repair.

7. Leave the SBU motionless until the motion detector resets. Move the SBU so it tilts over a couple of inches. This should trigger the impulse detector; the waveform on pin 6 should go to 5V or 0V.

8. Rock the SBU back and forth at about 3 Hz. Check the vibration output (pin 8) on the scope; the vibration level should drop towards 0V with increasing amplitude.

2.6.2.2 Functional Check of New Style Solid State Motion Detector

Preparation:

1. Prepare a small level work area and use the circular bubble-level to assure that the surface is actually level.

2. Preset the power supply output voltage to 5.0 Vdc +/- 0.1V. Turn off the power supply.

3. Remove the JP2 jumper plug from its dummy terminal posts located just outside and to the left of the RF shield box. Install this shorting, jumper-plug onto the JP1 terminal posts inside the RF shield box.

4. Using a short lead with very small Pomona clips, short pins 4 and 6 of terminal strip J2.

NOTE

For test and measurement purposes, any circuit-common connections can be made to pin 6 of J2 or to the shield fence which is electrically the same point and more convenient.

2.5 Volt Bias Adjustment:

1. Connect the positive (+) terminal of the 5V power supply to pin 1 of terminal strip J2 using very small Pomona clips. Connect the common terminal of the 5V power supply to pin 6 of terminal strip J2 or to the shield fence.

2. Using very small Pomona clips, connect the Digital Multimeter (DMM) to pin 5 of terminal strip J2 and circuit common. The positive meter lead will connect to pin 5 and the negative meter lead will connect to circuit common at pin 6 of J2 or the shield fence.

3. Hold the motion detector assembly against the flat surface by applying pressure to the bottom rear of the bracket using your finger or a small weight. The motion detector assembly must remain level and completely motionless during this adjustment. Turn on the 5V power supply.

4. Adjust the R15 potentiometer until the DMM reads 2.5Vdc +/- 0.05V.

5. Turn off the power supply but leave it connected to the assembly.

6. Place a drop of Glyptol (or fingernail polish) onto the side of the adjuster screw of R15 to prevent it from turning.

Testing the Integrity of the Board Connector J1 and Its Associated Board Traces:

1. Move the positive lead of the DMM to pin 2 of J1 and the negative lead to pin 3 of J1.
2. Turn on the power supply.
3. The voltage indicated on the DMM should be 5 +/- .1Vdc.
4. Move the negative lead of the DMM to pin 4 of J1.
5. The voltage indicated on the DMM should be 5 +/- .1Vdc.
6. Move the positive lead of the DMM to pin 8 of J1. With the unit completely motionless (LED 1&2 are lit), the voltage should be between 4.5 and 5.0Vdc.
7. Turn off the power supply but leave it connected to the assembly.
8. Setup the DMM to read "Ohms."
9. Connect one lead of the DMM to pin 1 of J1. Touch the other lead to pin 2 of J1 and then to pin 3 of J1. The DMM should indicate an open-circuit condition for both.
10. Connect one lead of the DMM to pin 10 of J1. Touch the other lead to pin 8 of J1. The DMM should indicate an open-circuit.
11. Reconfigure the DMM to read DC Volts.

NOTE

Pins 5, 7 and 9 are not tested because they are not used on the Motion Detector Assembly or the End-of-Train unit motherboard. Pin 6 will be tested in the following section.

Motion and Direction Verification:

In the following steps, the on-board, 3-LED array will be used along with the DMM as a motion and direction state indicator. The truth table for the three LEDs is shown in Table 2.3 below. A "1" means the LED is lit, a "0" means it is dark.

LED Status				
LED1(Gr)	**LED2(Red)**	**LED3(Red)**	**Condition**	**DMM Reading**
1	1	0	Stopped	2.4 - 2.6 VDC
0	0	0	Forward	4.8 - 5.1 VDC
0	0	1	Reverse	0.0 - 0.3 VDC

Table 2.3 - Solid State Motion Detector Direction State

1. Move the positive lead of the DMM to pin 6 of connector J1 and the negative lead to the shield fence.
2. Remove the shorting jumper between pins 4 and 6 of terminal strip J2.

3. With the unit completely motionless, turn on the power supply and observe the LED array, consisting of LED 1, 2, and 3. At power-on and with a motionless unit, the LED status should indicate the “stopped” condition of Table 2.3. That is, LED1 (Green) should be lit, LED2 (Red) should be lit and LED3 should be dark. If this is not the case, you may have bumped or moved the unit. Wait 20-25 seconds to see if the LED status changes. The DMM reading should be between 2.4 and 2.6Vdc.

4. With the unit in the “stopped” condition, tap the rear of the unit as shown in Figure 2-2. The LED status should indicate the “forward” condition in Table 2.3. That is, all the LEDs should be dark. The DMM reading should be between 4.8 and 5.1Vdc.

5. After the unit has returned to the “stopped” condition, tap the front of the unit as shown in Figure 2-3. The LED status should indicate the “reverse” condition in Table 2.3. That is, only LED3 should be lit. The DMM reading should be between 0.0 and 0.1Vdc.

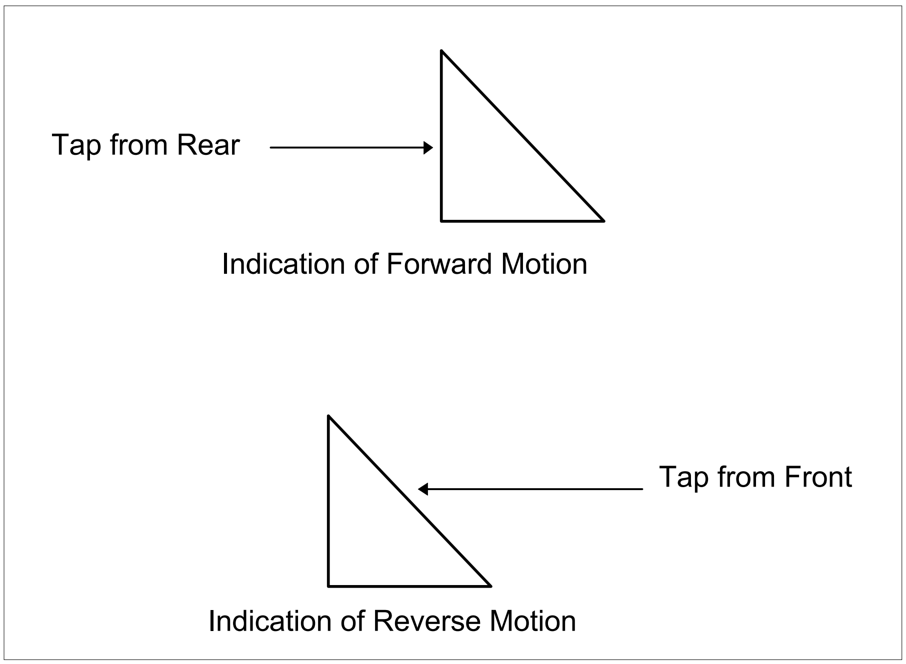


Figure 2-3 - Indication of Forward and Reverse Motion

Motion to No-Motion Time-out Verification:

This next step will verify the time it takes to register a “stopped” condition, once motion has actually ceased.

1. Tap the unit from either the front or the rear and note that the green LED (LED1) has gone dark. The green LED should light between 8 and 22 seconds.

2. Turn off the power supply.

Power Cycle Timing Verification:

1. Connect the oscilloscope probe ground clip to the shield fence and the probe tip to pin 3 of terminal strip J2.

On-Time Measurement: Reference Figure 2-4.

2. Set the scope vertical attenuator to 1V/div. and the sweep speed to 10msec/div. Set the trigger to “Normal,” positive slope detection and the trigger level to about .2 volts.

3. Turn on the power supply.

4. With the unit completely motionless, the scope trace should indicate a steady-state level greater than 4.8 volts.

5. Bump the Motion Detector to indicate motion. When this is done, the scope should trigger on the rising edge of the turn-on pulse. The pulse duration should be between 80 and 86 msec. Adjust the trigger and horizontal position controls to fit the trace on the screen for easy measurement. If the scope has cursors, they may be helpful in making a quick and accurate measurement. Refer to Figure 2-4 and verify the given timing parameters.

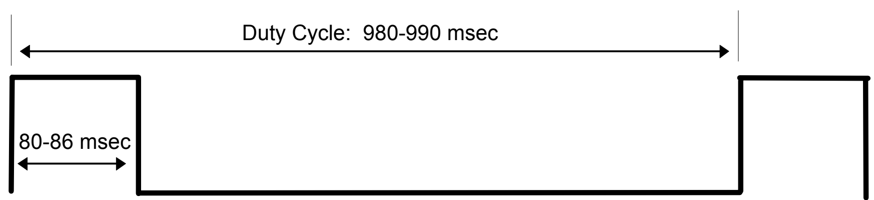


Figure 2-4 - Waveform on Pin 3 of J2

Off-Time Measurement: Reference Figure 2-4

6. Change the scope sweep speed to 250msec/div.

7. Bump the Motion Detector to indicate motion. When this is done, the scope should trigger and display at least two (2) cycles of the pulse train. Use the screen cursors to measure the duty cycle time. The duty cycle should be between 980 and 990msec. Refer to Figure 2-4 and verify the given timing parameters.

8. Turn off the power supply and disconnect all test equipment and jumper leads.

9. Remove the jumper plug from JP1 and install it onto the JP2 dummy pins outside the RF shield box.

10. Carefully position the lid of the RF shield box onto the shield fence and softly press the lid to a full seated position.

2.6.3 Emergency Valve Inspection

1. Inspect the emergency brake exhaust valve brakeline air filter screen, visible from the inlet port of the valve. Remove any particles, being careful not to force them inside the valve.
2. Check the emergency brake exhaust valve piston movement by pressing on it. When fully depressed, the piston should completely clear the emergency brake valve exhaust hole.
3. Apply greater than 30 psig/207 kpa to the SBU and close the supply valve. Depress the pressure relief valve on the emergency brake exhaust valve and check that all air is exhausted.
4. Apply 85 psig/586 kpa air pressure to the SBU, then close the air supply valve. Listen for air leaks at the emergency brake exhaust valve and at both ends of the air hose. The pressure should not drop by more than 8 psig/55 kpa in 1 minute. If an air leak is suspected at a certain component, apply soapy water to the area in question and watch for bubbles. Correct if necessary. Perform Emergency tests as stated in section 2.3.7.

If the emergency brake exhaust valve is found to be faulty, it should be returned to US&S for inspection. Attempting to service the emergency brake exhaust valve is not recommended. The valve requires no lubrication and has no user repairable parts.

2.6.4 Transceiver Module Alignment and Calibration

The following procedure describes how to align and calibrate the SBU Transceiver Module. The procedure applies to both the Motorola and Johnson Data Telemetry (JDT) type transceivers. This is followed by specific information for performing adjustments for each type of radio.

During the course of the procedure, refer to Section 3.0, which describes how to use the Diagnostic Software to perform radio adjustments.

2.6.4.1 Removal of SBU Rear Panel

1. Using a 5/32" Allen wrench, remove the 6 hexhead capscrews securing the rear panel. Carefully lift off the rear panel.
2. Inspect the rear panel and gasket for damage. If damage is noted, replace the panel and/or gasket before re-installing the rear panel.

NOTE

In SBUs equipped for secondary air pressure measurement, an additional air hose is fitted to the rear panel. When removing the panel, unplug the auxiliary pressure transducer connector from the SBU processor board.

2.6.4.2 Equipment Setup

1. Disconnect the SBU antenna BNC connector from the transciever and connect a watt meter in series with the transceiver and antenna as shown in Figure 2-5.

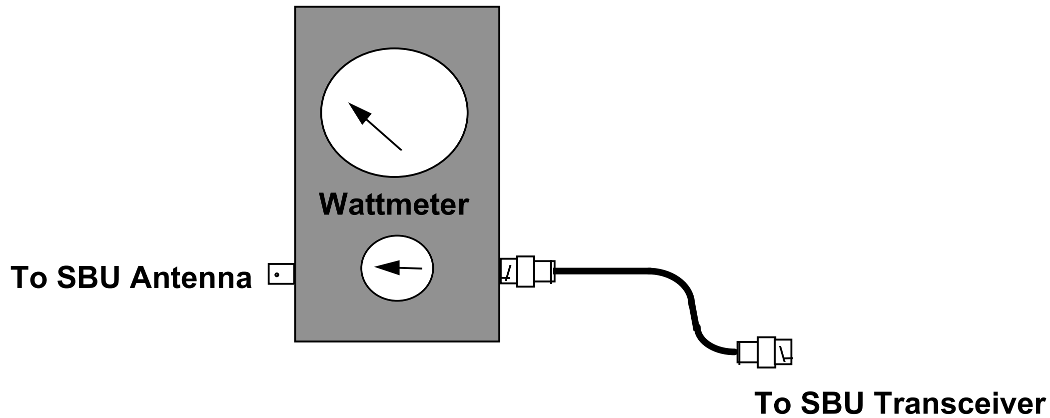


Figure 2-5 - Use of Watt Meter

2. Connect a Radio Test Cable to J7 on the SBU Processor Board. Note that Pin 1 on J7 is at the bottom. The Radio Test Cable is constructed as shown in Figure 2-6.

   Note: See Figure 2-7 for location of J7 and adjustment trimpots on the SBU Processor Board.

3. Open the battery compartment and connect the Diagnostic PC, via the serial communications cable, to the DB-9 Diagnostic Connector located in the battery compartment.

4. Apply power to the SBU.

5. Execute the PC Diagnostic Software from the floppy disk or hard drive as instructed in Section 3.0.

Press the SBU TEST button to initiate communications between the SBU and the PC.

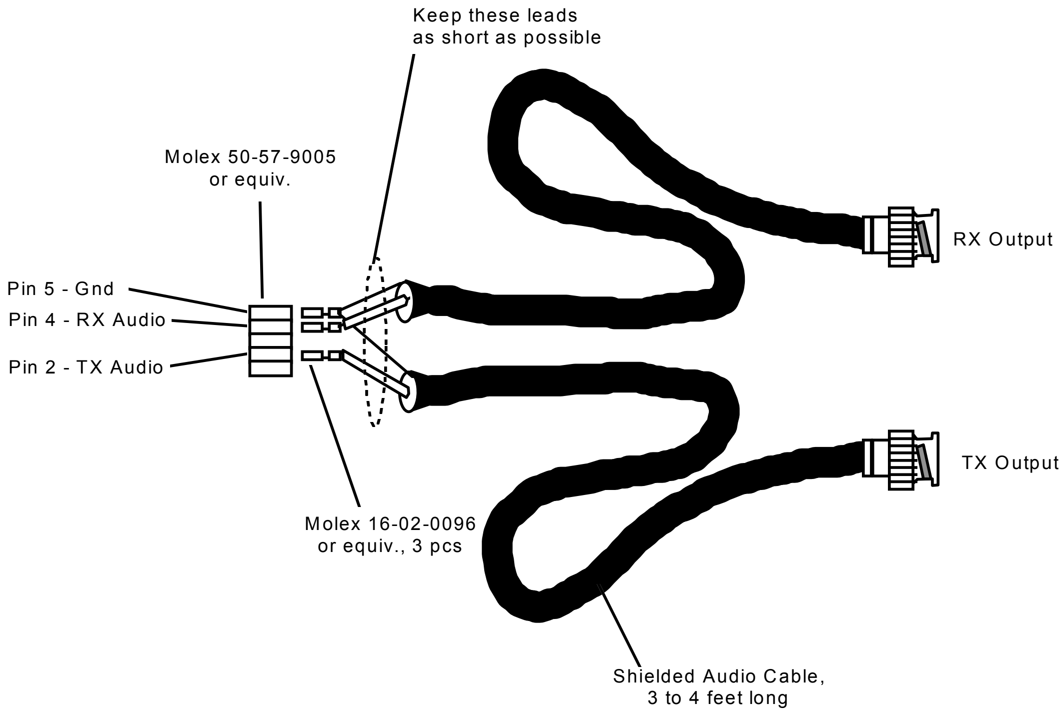


Figure 2-6 - SBU Radio Test Cable

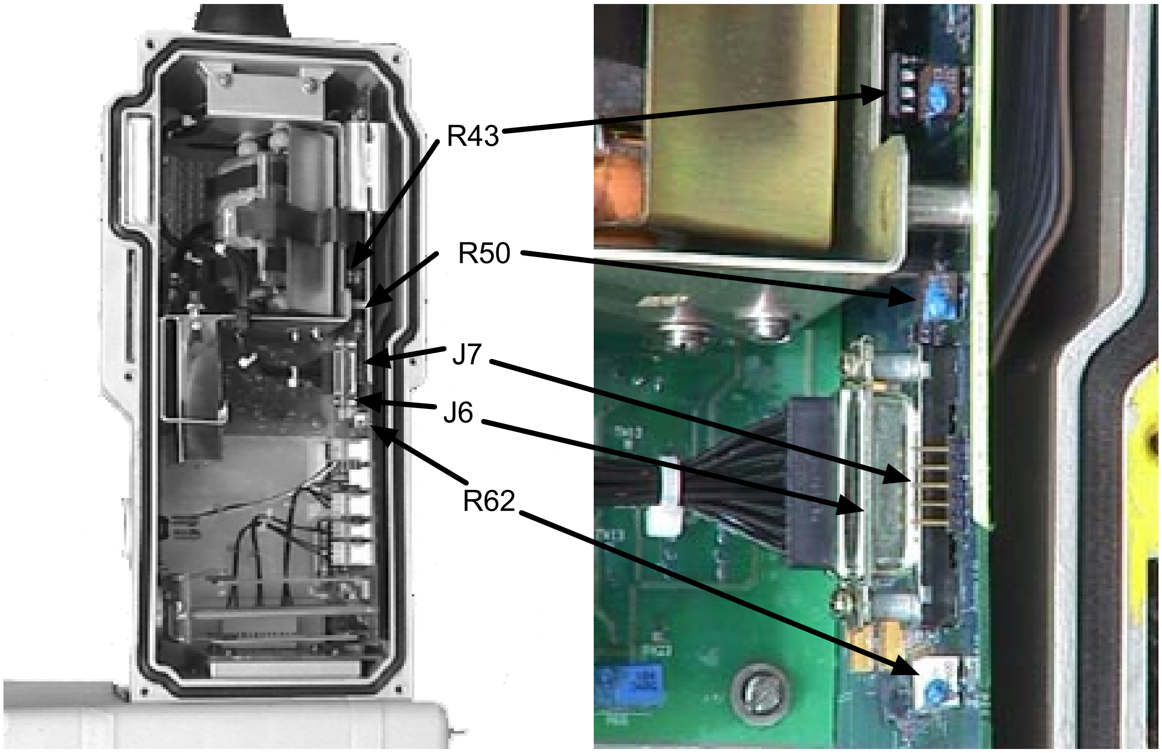


Figure 2-7 - Component Locations on SBU Processor Board

2.6.4.3 RF Transmit Power

1. Using the PC and Diagnostic Software, transmit a continuous, unmodulated carrier. Adjust the **RF GAIN** pot, **R62**, for a transmitter output of 2 watts to the antenna. The test software will key the radio transmitter for 50 seconds.

   If the transmitter times out before the adjustment has been made, use the PC to repeat the transmission of the carrier. If **R62** is adjusted, “re-lock” with Glyptol or equivalent. To stop the transmission at any time, or once complete, press <**Esc**>.

2. Check the reflected power to verify that the SWR is less than 1.5 : 1. Use the Diagnostic Software to re-transmit a carrier.

3. Disconnect the Watt Meter from the SBU and connect the SBU to the Communications Monitor RF IN/OUT port as shown in Figure 2-8.

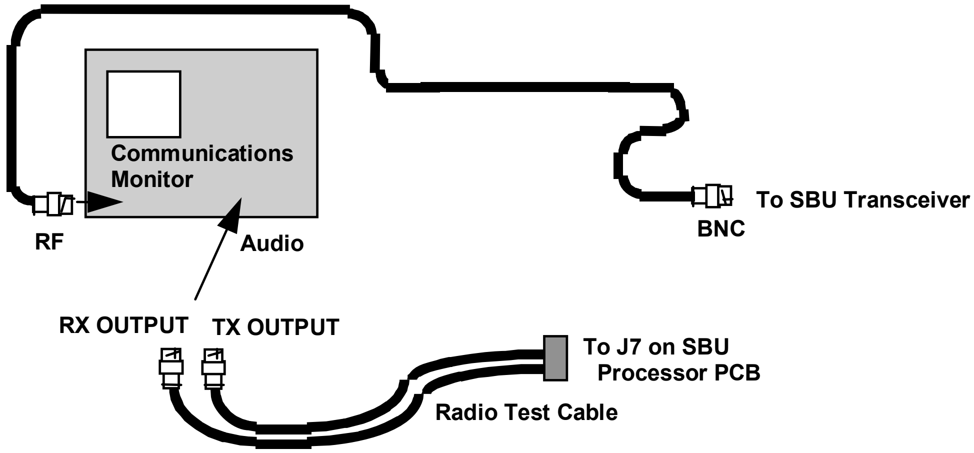


Figure 2-8 - Connection to Communications Monitor

2.6.4.4 Transmitter Center Frequency

WARNING

For all transmitter tests, ensure that the Transceiver's antenna output is connected to an antenna, RF Monitor, or 50 ohm dummy load, when initiating transmissions. Lack of an RF load can cause overheating of the transmitter and eventual failure.

1. Check the transmit center frequency for the Motorola or Johnson Data Telemetry transceiver module as follows:

   a. Use the PC Diagnostic Software to transmit an unmodulated carrier.

   b. Using the communication monitor, verify that the TX center frequency is as listed in Table 2.4 (Motorola RNET 450 Radio) or Table 2.5 (Johnson Radio).

Country/Part Number	Transmit Frequency	Receive Frequency	RX Local Oscillator Frequency
North America (P/N: N24600004)	457.9375 Mhz	452.9375 Mhz	407.9375 Mhz
Australia (P/N: N24600005)	450.250 Mhz	450.250 Mhz	405.250 Mhz

Table 2.4 – Motorola RNET 450 Radio Transmit and Receive Frequencies

Country/Part Number	Transmit Frequency	Receive Frequency	RX Local Oscillator Frequency
North America (P/N: N24600007)	457.9375 MHz	452.9375 MHz	N/A
Australia (P/N: N24600009)	477.700 MHz	472.500 MHz	N/A
Finland (P/N: N24600010)	457.650 MHz	467.650 MHz	N/A
Argentina (P/N: N24600011)	458.075 MHz	458.075 MHz	N/A

Table 2.5 – Johnson Data Telemetry Radio Transmit and Receive Frequencies

2.6.4.5 TX Center Freq for Motorola RNET 450 Transceiver

1. This procedure only applies to SBUs equipped with the Motorola Transceiver

2. The center frequency should be within +/- 2.29 KHz. If the reading is out of tolerance, correct by adjusting **Coil L101** in the Motorola radio. **Coil L101** is located inside the module as shown in Figure 2-9. This adjustment should be set for +/- 200 Hz at room ambient temperature.

   When adjusting the transmitter center frequency, check for frequency drift over a period of several minutes. Perform this by using the Diagnostics PC to key the radio for a short time (e.g., 5 seconds) for each check. It is NORMAL for a good radio to drift slightly (e.g., ± 1000 Hz). If the radio continues to drift outside the tolerance value of +/- 2.29 KHz, it should NOT be put into service.

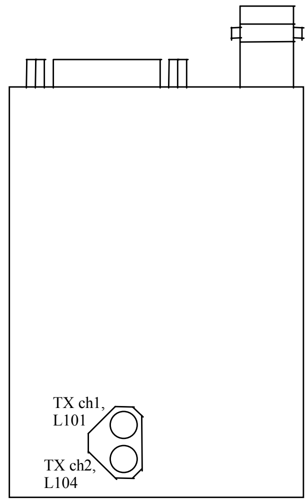


Figure 2-9 - Motorola Transceiver Coil L101 Location

2.6.4.6 Receiver Center Frequency for Motorola RNET 450

1. Remove power from the SBU by removing the battery and install the Radio TX Inhibit Adapter (as shown in Figure 2-10) between the radio cable connector (15 pin "D" type) and J6 on the SBU Processor PCB. This inhibits all transmissions initiated by the SBU to prevent possible damage to the communication monitor. Re-apply power to the SBU by reinstalling the battery.

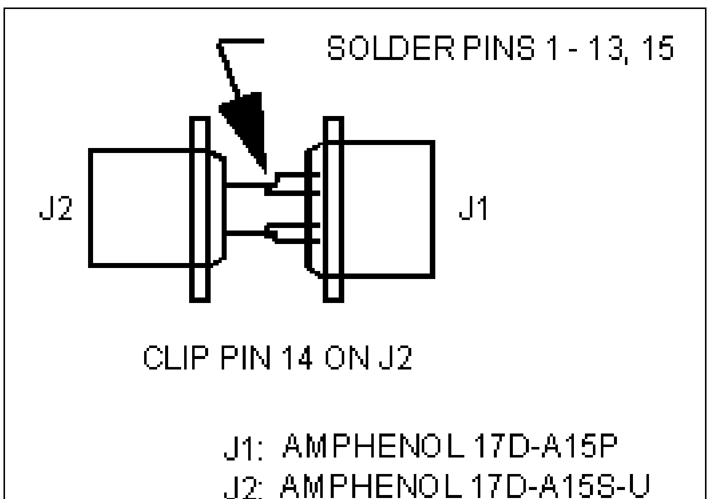


Figure 2-10 - Radio TX Inhibit Adapter Connector

2. Connect the radio to the antenna input of the communications monitor and set the center frequency of the monitor as specified in Table 2.4 for local oscillator frequency. Measure receive frequency error. The error measured must be within $\pm$ 4.53KHz.

3. Once complete, remove power, re-connect the radio antenna cable to the BNC connector of the transceiver and then remove the adapter from J6 and the radio cable. Re-connect the radio cable to J6 insuring that both screws are seated. Re-apply power to the SBU.

2.6.4.7 TX Center Freq for Johnson Data Telemetry (JDT) Transceiver

1. The Johnson Data Telemetry (JDT) transceiver is a synthesized UHF type radio. The transmitter center frequency is controlled by a Temperature Compensated Crystal Oscillator (TCXO), which has a frequency stability of ± 1.5 parts per million over its operating temperature range.

   The Transmit Center Frequency should be measured and be within ± 675 Hz. The Receive Center Frequency does not need to be checked. It will be correct, if Transmit Center Frequency is correct.

   If the center frequency measurement is ouside the ± 675 Hz range, the **TCXO** must be adjusted. This is done by removing the JDT module's cover, and locating the **"FREQ. ADJ. ACCESS HOLE"** on the bottom side of the Loader Board as shown in Figure 2-11. Use a small screwdriver to adjust the **TCXO** for the desired frequency.

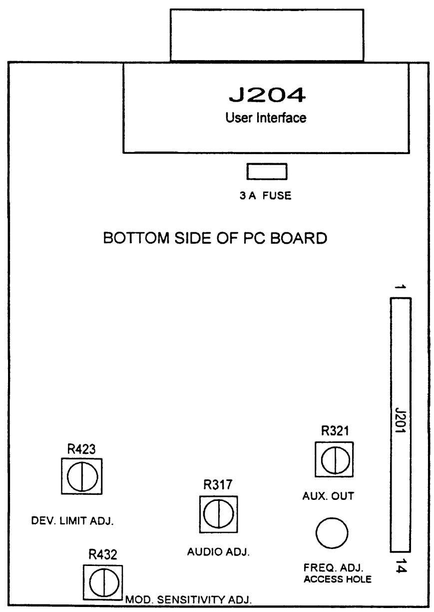


Figure 2-11 - JDT Transceiver Frequency Adjust Access Hole Location (Cover Removed)

2.6.5 Transmitter Deviation

1. The following procedures apply to all of the the JDT radio module versions <u>except</u> for the Australian version radio (p/n: N24600009) which is described separately in Step 3.

2. Using the PC, transmit a Continuous Message Preamble. Adjust the **TX.GAIN** pot, **R50**, for **3.0KHz ±.1KHz** deviation. The communications monitor should be set as specified in Table 2.5 for the applicable TX frequency. The test software will key the radio transmitter for 50 seconds. If **R50** is adjusted, "re-lock" with Glyptol or equivalent.

Australian JDT Radio

3. For the Australian version JDT radio (p/n: N24600009), repeat Step 2 above, but adjust the **TX.GAIN** pot, **R50**, for **2.0KHz ±.1KHz** deviation.

2.6.6 Receive Audio Level

1. The following procedures apply to all of the the JDT radio module versions <u>except</u> for the Australian version radio (p/n: N24600009) which is described separately in Step 3.

2. Setup the communication monitor to generate a signal specified **in Table 2.5 for Receive Frequency, - 60dbm**, frequency modulated at **±3.0KHz deviation**, and **1200Hz audio tone**. Adjust the **RX.GAIN** pot, **R43**, for an output of **4 volts peak to peak** at the RX OUTPUT of the Radio Test Cable. The communication monitor should be used to both generate the RF output being fed into the radio and also to monitor the audio output from the SBU's filter (RX OUTPUT). If the communication monitor can not be used to set the RX OUTPUT, use an oscilloscope. If **R43** is adjusted, “re-lock” with Glyptol or equivalent.

3. Setup the communication monitor for **1800Hz audio tone**. Measure the peak to peak amplitude of the RX OUTPUT. The signal should be between **3.7 and 4.5 volts peak to peak**.

<u>Australian JDT Radio</u>

4. Setup the communication monitor to generate a signal specified **in Table 2.5 for Receive Frequency, - 90dbm**, frequency modulated at **±2.0KHz deviation**, and **1500Hz audio tone**. Adjust the **RX.GAIN** pot, **R43**, for an output of **300 mVp-p to 1200 mVp-p** at the RX OUTPUT of the Radio Test Cable. The communication monitor should be used to both generate the RF output being fed into the radio and also to monitor the audio output from the SBU's filter (RX OUTPUT). If the communication monitor can not be used to set the RX OUTPUT, use an oscilloscope. If **R43** is adjusted, “re-lock” with Glyptol or equivalent.

5. Once complete, disconnect the Radio Test Cable from the SBU.

2.6.7 Measuring Receiver Sensitivity Using SINAD

The sensitivity of a receiver is defined as the minimum level of an "appropriately modulated," input signal that will produce a desired, intelligible output signal that is a specified level <u>above</u> the normal background noise. SINAD is the gauge by which a receiver’s capability of separating the desired signal from the noise can be measured.

The SINAD measurement technique used in the Land Mobile Radio Service involves injecting an RF signal that is FM-modulated with a one (1) KHz tone (with a deviation equivalent to that seen in normal service) into the receiver RF input and measuring the resulting audio output signal. The device used to measure SINAD is often called a “SINADDER,” but most Communication Analyzers, such as the Motorola R-2600 also have this capability. The term SINADDER is used hereafter as a generic term for all such devices.

The signal at the audio output of the receiver (which is composed of the demodulated 1 KHz tone, all internally and externally generated noise, plus any receiver induced distortion) is simultaneously measured two different ways by the SINADDER, as a “raw” signal and after

being filtering by a narrow, low loss, bandstop 1 KHz filter. The filtered signal, stripped of the audio tone, contains only the internally and externally generated noise and distortion. Allowing for the filter insertion loss, the ratio of these two levels (signal-plus-noise-plus-distortion to noise-plus-distortion) is the SINAD and is typically computed and displayed automatically. The ratio is expressed in decibels, with the standard value being -12 dB.

2.6.7.1 Measuring the SINAD

To enhance the signal and suppress the noise, the SBU is equipped with an audio bandpass filter that was optimized for the modem frequencies of 1200 and 1800 Hz. To correctly measure the SBU receiver's sensitivity using the SINAD technique, it is necessary to treat the receiver and audio filter as a "system." Measure the SINAD as follows:

1. Remove the SBU's Rear Panel.

2. Connect the SBU Radio Test Cable (See Figure 2-56) from the output of the audio output filter at J7 (located beside the 15 pin "D" connector on the Processor Board) to the audio input of the SINADDER. Be sure to insert the connector in the proper orientation. This is a relatively noisy place on the PC board; so for best results, use a shielded cable keeping the center conductor length near the pins to an absolute minimum.

3. Disconnect the SBU antenna at the BNC connector on the top of the radio.

4. Set an FM-modulated RF Generator as follows and connect to the radio antenna input with a short BNC Cable:

RF Output Frequency:	See Tables 2.4 and 2.5 for RF Frequency
RF Output Level:	50 dBm
Modulation:	1 KHz Sinewave
Deviation:	3.0 KHz deviation, 2.0 Khz (for Australia JDT Radio)

5. In Normal operation, the receiver is turned on three (3) times per second to listen for the Cab Unit signal. If nothing is heard, the receiver is turned off again to minimize the power consumption. It is impossible to correctly measure the SINAD under these conditions. However, when the SBU is placed in PC diagnostics mode, the receiver is turned on continuously.

6. Insert a battery into the SBU or connect a 12 VDC bench power supply to the battery pins. Be sure to observe proper polarity.

7. Run the Diagnostic Software as described in Section 3.0. It is not necessary to make a selection at this time. The receiver will be on continuously for any "non-transmit" mode.

8. Set up a SINADDER to measure SINAD and begin reducing the RF signal level until the SINAD is -12 dB. The output level of the RF generator in µV (or dBm) is the reference sensitivity of the receiver. The sensitivity should be 0.4µV (-115 dBm) or less. If the measured sensitivity exceeds 0.4µV (-115 dBm), <u>the Transceiver Module should be replaced</u>.

9. Disconnect the test equipment and reinstall the Rear Panel.

2.7 TROUBLESHOOTING GUIDE

2.7.1 System-Level

The DIGITAIR® system consists of the Model 6695-CC SBU and a Cab Display Unit (e.g., CDU Model 6696). If a fault occurs in the system, try to isolate the problem to either the SBU or CDU. To do this, exchange each unit in turn with a known good unit. Also use the built-in Test Modes described in Section 2.6.

Once the problem has been determined to be a fault in the SBU, it will be one of two types:

1. SBU does not work at all.
2. SBU works incorrectly, intermittently, or partially.

For the first type of fault, verify that the SBU is receiving power by examining the fuses and protection diodes located under the black plastic cover in the battery compartment. Also verify that the TEST push-button is making contact when pressed.

For the second type of fault, troubleshoot the unit to identify the faulty PCB or electrical component for each of the SBU major assemblies listed below. Refer to the assembly drawings, schematic diagrams, and associated parts lists provided in Appendix A.

1. Back Cover Assembly (Dual Pressure Type SBU)
   - Pressure Transducer/Air Hose/Glad-Hand Assembly
2. Battery Compartment
   - EOT Battery PCBs
   - EOT Interface PCB (includes fuses)
3. Electronics Cage Assembly
   - Radio Transceiver Module
   - EOT Processor PCB
   - EOT Marker Light PCB
   - EOT Display PCB
   - Motion Detector Module
   - EPROM
4. Air Manifold Assembly
   - Solenoid Valve Assembly
   - Pressure Switch
   - Pressure Transducer

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3.0 SBU DIAGNOSTICS AND CALIBRATION

The SBU Model 6695-CC does not rely on a dedicated external device for unit diagnostics. All of the unit diagnostic tests and calibration functions are included on the DIGITAIR® Diagnostics Software Disk. This runs on a standard DOS-compatible personal computer (PC), which plugs into the SBU's diagnostic port located in the battery compartment, via a standard, off-the-shelf, "straight-through," male-to-female, DB-9 type serial communications cable. The cable is available in most computer and office supply stores.

3.1 DIAGNOSTIC SOFTWARE DISK

The Diagnostic Software Disk contains a single program named **diagunit.exe**. The software can be ordered under US&S part number N451232-1264 (3.5" disk) or N451232-1265 (5.25" disk). The software incorporates a full set of diagnostic functions for maintenance purposes and supports the capability to fully configure the SBU's operating features.

This manual provides examples of the configuration functions and provides detailed information on SBU diagnostics. Refer to Service Manual* 7065 (Installation & Operation) *for detailed configuration information and procedures.

3.2 CONNECTING THE DIAGNOSTICS COMPUTER

1. Open the battery compartment.

2. Plug the serial communications cable between the diagnostics computer and the DB-9 Diagnostic Connector located in the battery compartment. This port is set up for 9600-baud, 8-data bits, 1-stop bit, no parity.

3.3 RUNNING THE DIAGNOSTIC SOFTWARE ON THE PC

To run the Diagnostics Software, perform the following:

1. Power-up the SBU and the PC.

2. Connect the 9-pin serial communications cable between the PC and the SBU's Diagnostic Port connector.

NOTE

The SBU's Diagnostics Port is permanently set up for 9600-baud, 8-data bits, 1-stop bit, and no parity.

3. On the PC, execute the PC Diagnostic Software from the floppy disk or from the hard disk if it has been copied there, by typing **"diagunit"** followed by **<Enter>**.

4. The Communications Set-Up Screen will appear as shown on the next page. The program name and version appear at the top of the screen. The box at the bottom of the screen displays any prompts for user input. The last line shows applicable PC function keys.

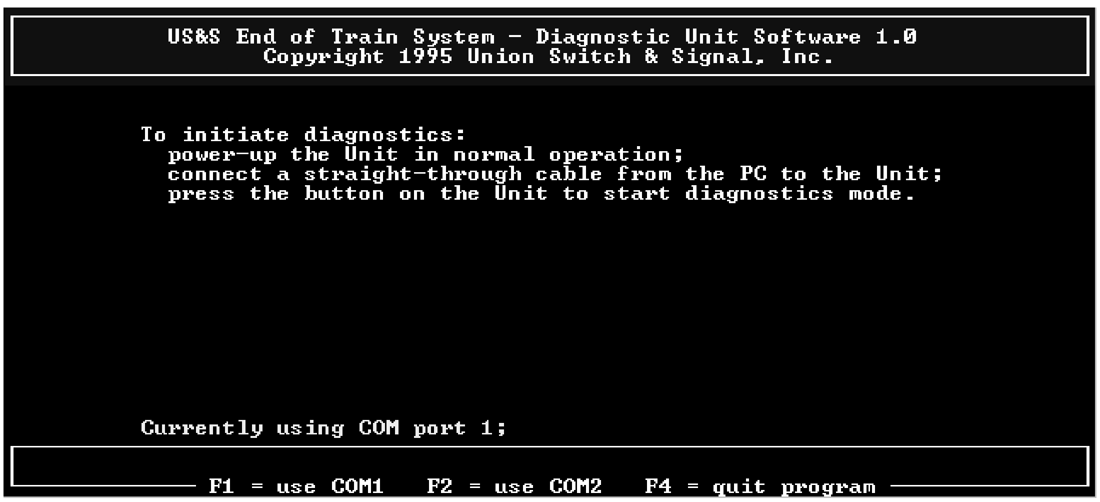
5. The software defaults to PC serial port COM1. If use of COM2 is required, press **<F2>** to use COM2. Press **<F1>** to return to COM1.

6. To quit the program at any time, press **<F4>**. The program will prompt with **“Really quit? [Y,N]:”**. If **“Y”** is selected, the program will terminate. If **“N”** is selected, the program continues.

7. To completely terminate the diagnostic mode in the SBU, unplug the communications cable and then either pressing the SBU TEST button or power down the unit by removing the battery.

NOTE

To activate the selected configuration feature or function, the Diagnostic Mode must be terminated in the SBU. This is done by unplugging the communications cable and then either pressing the SBU TEST button or powering down the unit by removing the batteries.

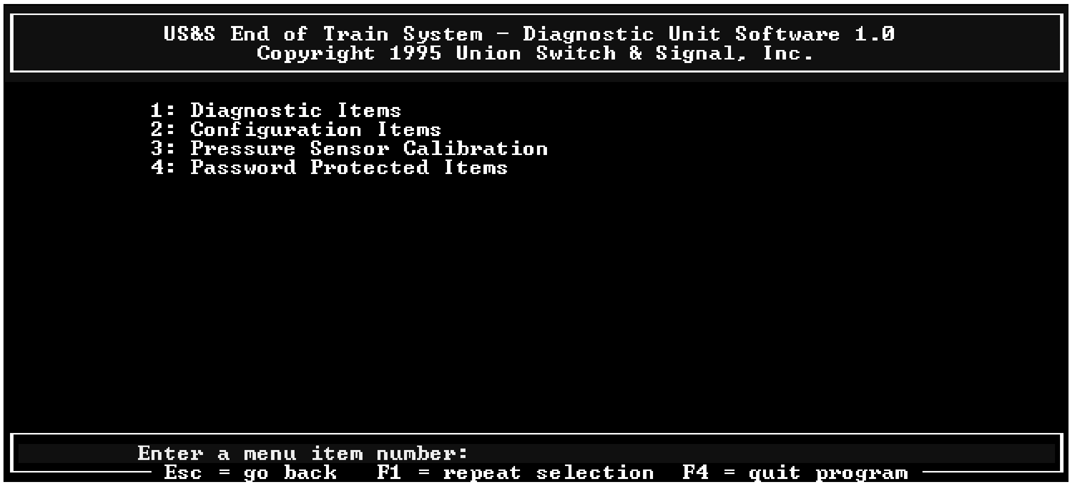


To initiate communications between the SBU and the diagnostic computer, briefly press the SBU TEST button. The Main Menu screen will appear.

At this point the user may select Diagnostics, Configuration, Calibration, or Password items.

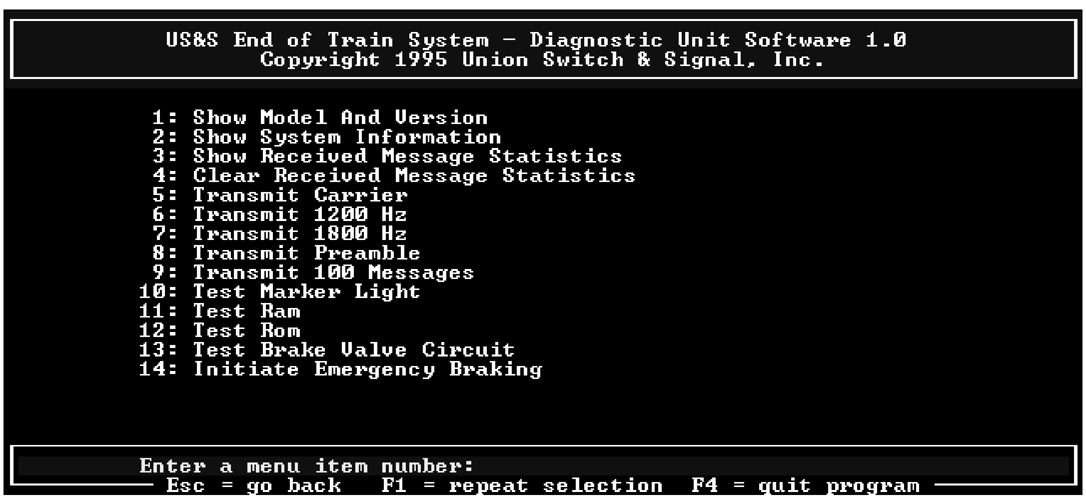
3.4 MAIN MENU

To proceed, select one of the sub-menus shown and press **<Enter>**.



3.5 DIAGNOSTICS MENU

The Diagnostic Items Menu displays selections that may display information about, or perform a diagnostic test on, the SBU.

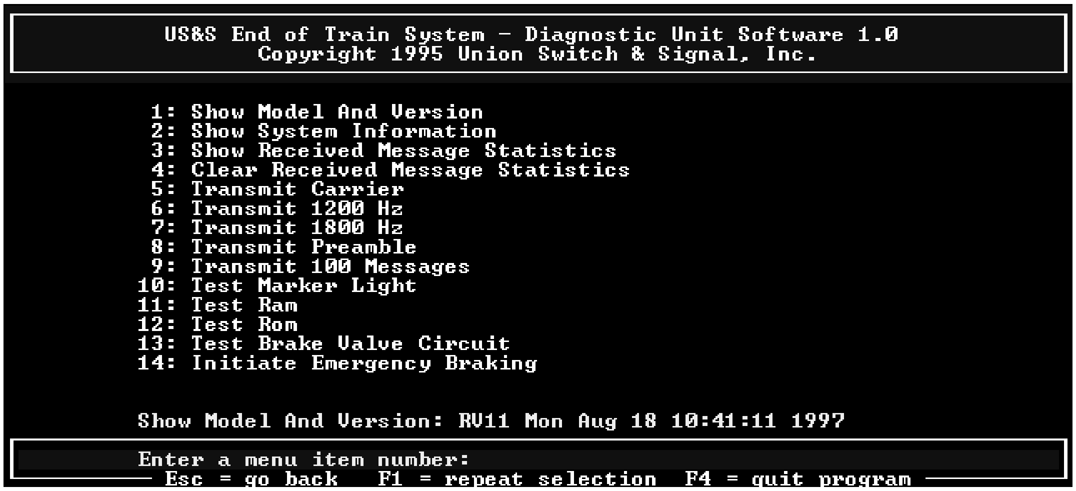


Select a diagnostic test from this menu by entering an item number and press **<Enter>**. To return to the Main Menu, press **<Esc>**.

If the item selected needs only a single line to display its result, the text will appear directly above the prompt box.

3.5.1   Software Version Number

If you wish to check the version number of the software residing in the SBU, press **<1>** (for "Show Model And Version") and then press **<Enter>**. The following screen will appear:

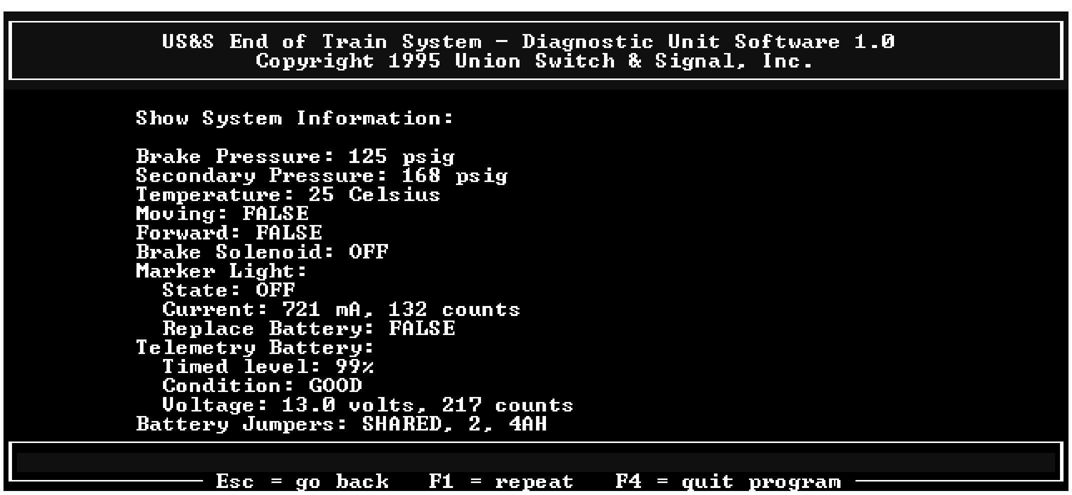


You may select another function or press **<Esc>** to return to the Main Diagnostics Menu.

3.5.2   System Information

If the item selected needs several lines to display its result, it will clear the screen and display the result in place of the menu.

For example, if you wish to examine the state of the SBU, press **<2>** (for "Show System Information") and then **<Enter>**. The following screen will appear:



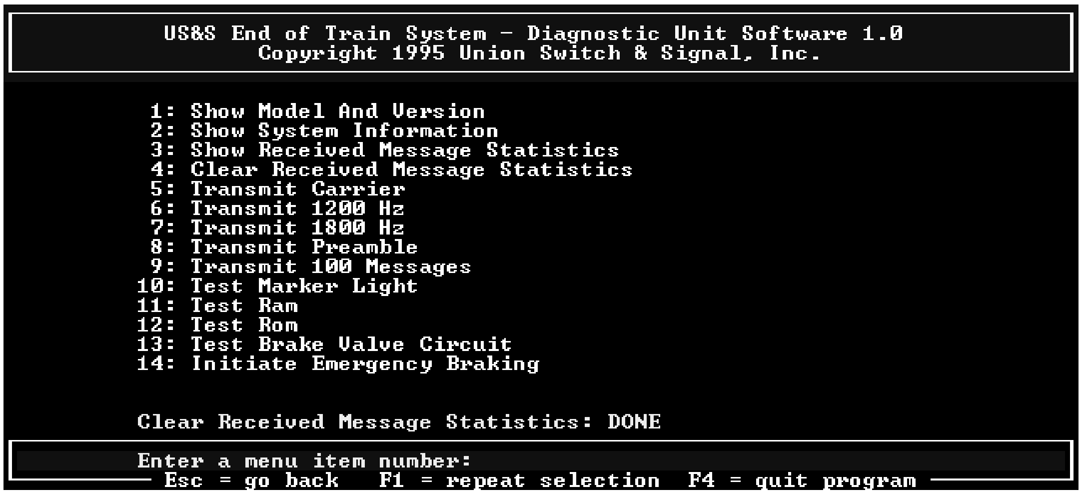
This screen permits the user to examine the brake and secondary air pressures, temperature, motion detector output, brake solenoid and Marker Light state, battery condition and strapping options.

To update this screen, press **<F1>**. To return to the Main Diagnostics Menu, press **<Esc>**.

3.5.3 Clear and Show Received Message Statistics

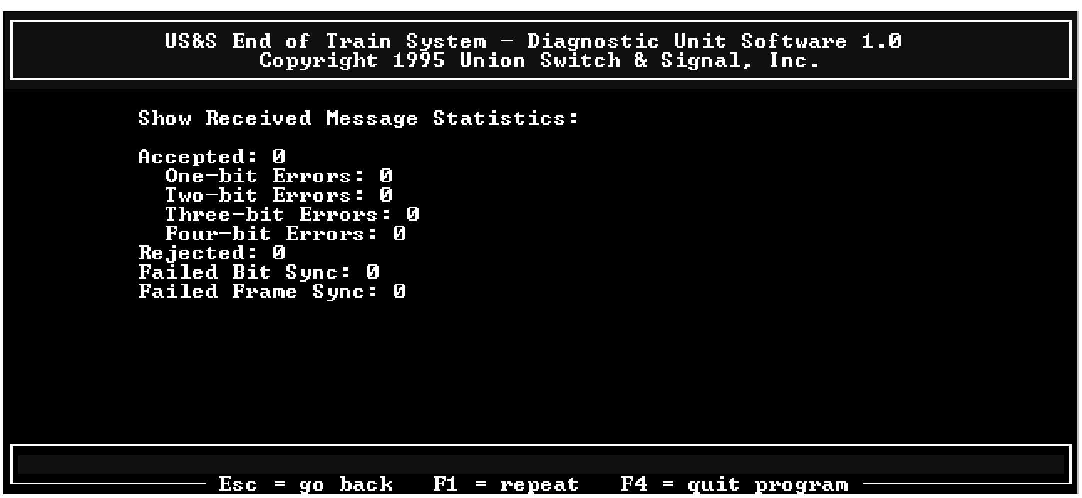
The SBU is constantly gathering statistical information about the received message failures and bit errors whenever it is operational. To measure the communication effectiveness of an SBU/CDU combination, it is necessary to first clear these totals.

Select "4" from the Main Diagnostics Menu and press **<Enter>**. The following screen will appear, to indicate that the statistics counters have all been zeroed.



3.5.4 Show Received Message Statistics

Place the CDU into the Continuous Transmit Mode. At any point you may select "3", and press **<Enter>** to display a “snapshot" of the statistics indicating the number of messages accepted and rejected and the types of bit errors encountered, if any, up to that point. To update the display, press **<F1>**.



To return to the Main Diagnostics Menu, press **<Esc>**.

3.5.5 Transmit a Continuous, Unmodulated Carrier

To transmit a steady, unmodulated carrier, return to the Main Diagnostics Menu and select "5" (for “Transmit Carrier”), and press **<Enter>**. The following screen will appear:

```
        US&S End of Train System - Diagnostic Unit Software 1.0
               Copyright 1995 Union Switch & Signal, Inc.

          1: Show Model And Version
          2: Show System Information
          3: Show Received Message Statistics
          4: Clear Received Message Statistics
          5: Transmit Carrier
          6: Transmit 1200 Hz
          7: Transmit 1800 Hz
          8: Transmit Preamble
          9: Transmit 100 Messages
         10: Test Marker Light
         11: Test Ram
         12: Test Rom
         13: Test Brake Valve Circuit
         14: Initiate Emergency Braking

         Transmit Carrier: INITIATED; duration = 50 seconds

         Enter a menu item number:
           Esc = go back   F1 = repeat selection   F4 = quit program
```

After 50 seconds, the carrier will turn off automatically. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.6 Transmit a Continuous, 1200 Hz Modulated Carrier

To transmit a steady, 1200 Hz modulated carrier, return to the Main Diagnostics Menu and select "6" (for “Transmit 1200 Hz”), and press **<Enter>**. The following screen will appear:

```
        US&S End of Train System - Diagnostic Unit Software 1.0
               Copyright 1995 Union Switch & Signal, Inc.

          1: Show Model And Version
          2: Show System Information
          3: Show Received Message Statistics
          4: Clear Received Message Statistics
          5: Transmit Carrier
          6: Transmit 1200 Hz
          7: Transmit 1800 Hz
          8: Transmit Preamble
          9: Transmit 100 Messages
         10: Test Marker Light
         11: Test Ram
         12: Test Rom
         13: Test Brake Valve Circuit
         14: Initiate Emergency Braking

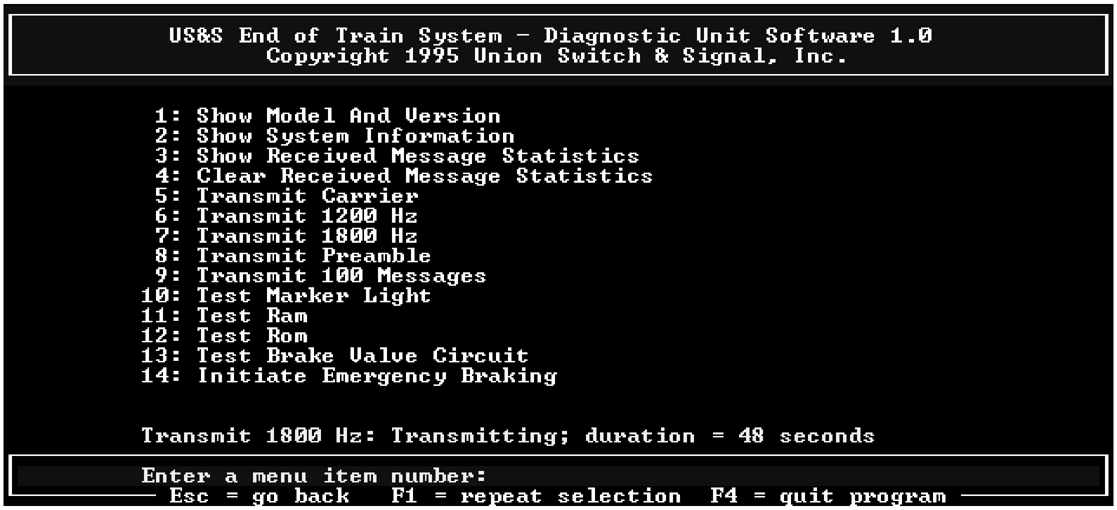
         Transmit 1200 Hz: Transmitting; duration = 48 seconds

         Enter a menu item number:
           Esc = go back   F1 = repeat selection   F4 = quit program
```

After 48 seconds, the carrier will turn off automatically. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.7 Transmit a Continuous, 1800 Hz Modulated Carrier

To transmit a steady, 1800 Hz modulated carrier, return to the Main Diagnostics Menu and select "7" (for “Transmit 1800 Hz”), then press **<Enter>**. The following screen will appear:



```
US&S End of Train System - Diagnostic Unit Software 1.0
Copyright 1995 Union Switch & Signal, Inc.

 1: Show Model And Version
 2: Show System Information
 3: Show Received Message Statistics
 4: Clear Received Message Statistics
 5: Transmit Carrier
 6: Transmit 1200 Hz
 7: Transmit 1800 Hz
 8: Transmit Preamble
 9: Transmit 100 Messages
10: Test Marker Light
11: Test Ram
12: Test Rom
13: Test Brake Valve Circuit
14: Initiate Emergency Braking

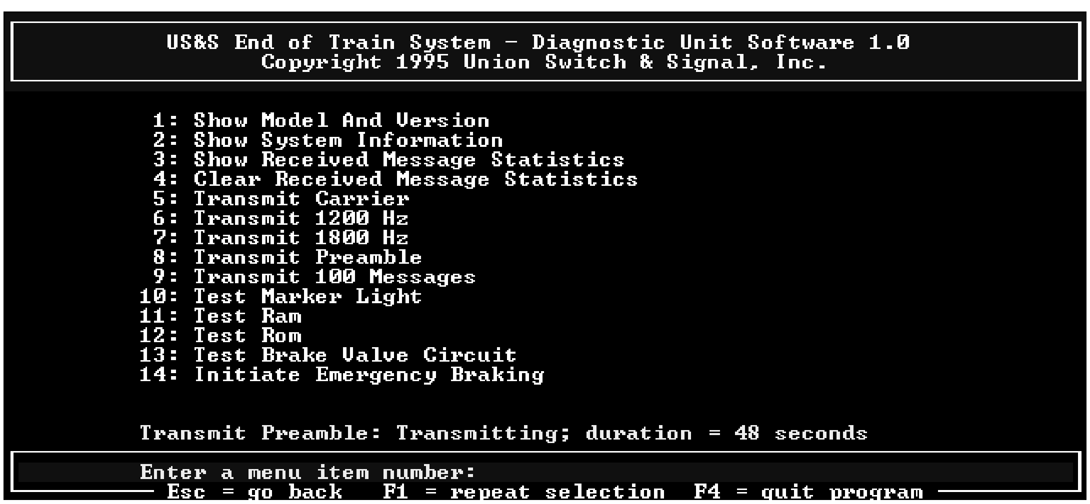
Transmit 1800 Hz: Transmitting; duration = 48 seconds

Enter a menu item number:
Esc = go back   F1 = repeat selection   F4 = quit program
```

After 48 seconds, the carrier will turn off automatically. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.8 Transmits Continuous Message Preamble

To transmit a alternating “101010...”, 1200 Hz/1800 Hz modulated message preamble, return to the Main Diagnostics Menu and select "8" (for “Transmit Preamble”), and press **<Enter>**. The following screen will appear:



```
US&S End of Train System - Diagnostic Unit Software 1.0
Copyright 1995 Union Switch & Signal, Inc.

 1: Show Model And Version
 2: Show System Information
 3: Show Received Message Statistics
 4: Clear Received Message Statistics
 5: Transmit Carrier
 6: Transmit 1200 Hz
 7: Transmit 1800 Hz
 8: Transmit Preamble
 9: Transmit 100 Messages
10: Test Marker Light
11: Test Ram
12: Test Rom
13: Test Brake Valve Circuit
14: Initiate Emergency Braking

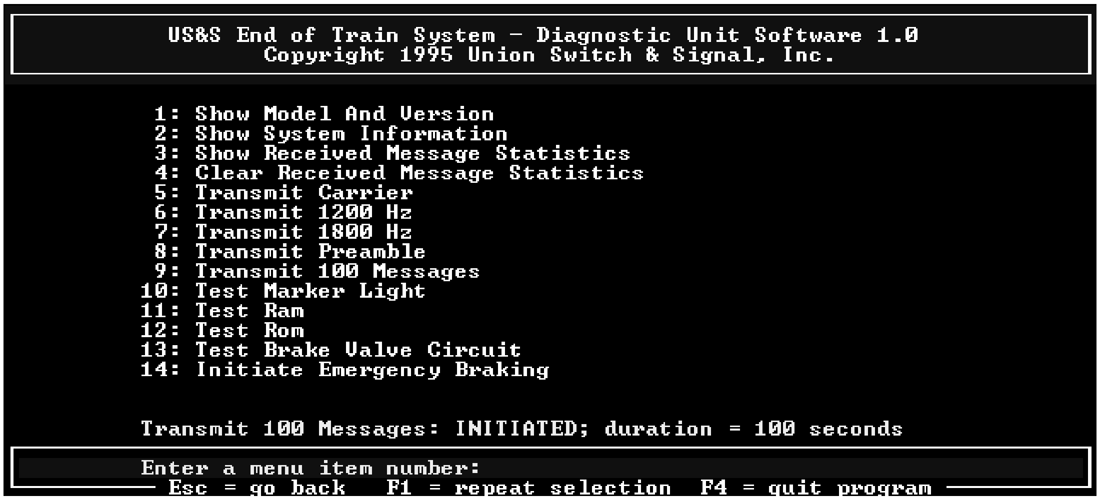
Transmit Preamble: Transmitting; duration = 48 seconds

Enter a menu item number:
Esc = go back   F1 = repeat selection   F4 = quit program
```

After 48 seconds, the carrier will turn off automatically. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.9 Transmit 100 Messages

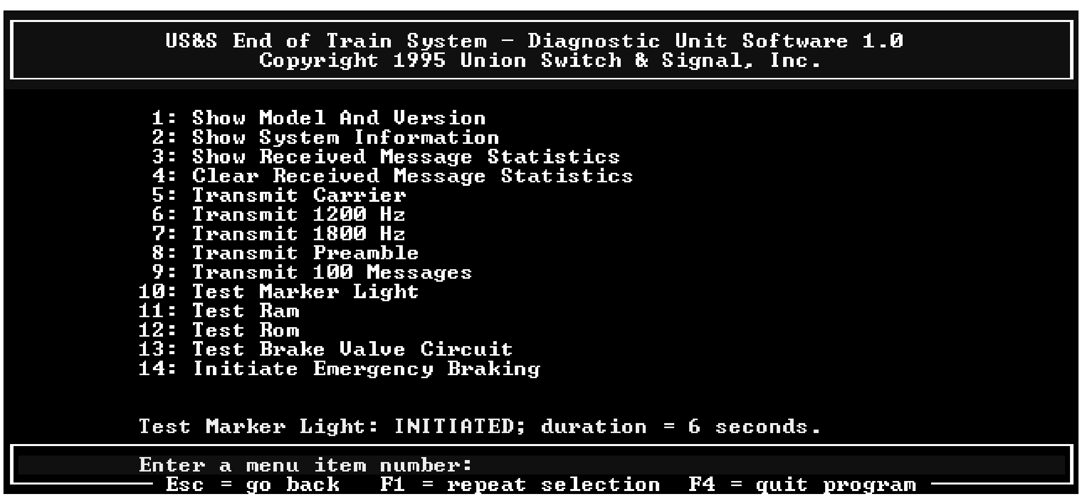
To transmit a series of 100 messages for statistical or test purposes, return to the Main Diagnostics Menu, select "9" (for “Transmit 100 Messages”), and press **<Enter>**. The following screen will appear:



After 100 messages, the carrier will turn off automatically. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.10 Test Marker Light

To initiate a test of the Marker Light, return to the Main Diagnostics Menu, select "10" (for “Test Marker Light”), and press **<Enter>**. The following screen will appear:



The Marker Light will flash (ON for 100 msec, OFF for 900 msec) for the defined Marker Light Test duration, regardless of ambient light conditions. When the indicated period has expired, the Marker Light will stop flashing. To modify the test period, see “Setting the Marker Light Test Duration,” under the Configuration section.

Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.11 Test RAM

To initiate a test of the SBU RAM memory, return to the Main Diagnostics Menu, select "11" (for "Test RAM"), and press **<Enter>**. The following screen will appear:

```
      US&S End of Train System - Diagnostic Unit Software 1.0
              Copyright 1995 Union Switch & Signal, Inc.

           1: Show Model And Version
           2: Show System Information
           3: Show Received Message Statistics
           4: Clear Received Message Statistics
           5: Transmit Carrier
           6: Transmit 1200 Hz
           7: Transmit 1800 Hz
           8: Transmit Preamble
           9: Transmit 100 Messages
          10: Test Marker Light
          11: Test Ram
          12: Test Rom
          13: Test Brake Valve Circuit
          14: Initiate Emergency Braking

          Test Ram: GOOD

          Enter a menu item number:
            Esc = go back   F1 = repeat selection   F4 = quit program
```

The response, "GOOD" or "BAD," is relatively instantaneous. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.12 Test ROM

To initiate a test of the SBU EPROM memory, return to the Main Diagnostics Menu and type "12" (for "Test ROM") and press **<Enter>**. The following screen will appear:

```
      US&S End of Train System - Diagnostic Unit Software 1.0
              Copyright 1995 Union Switch & Signal, Inc.

           1: Show Model And Version
           2: Show System Information
           3: Show Received Message Statistics
           4: Clear Received Message Statistics
           5: Transmit Carrier
           6: Transmit 1200 Hz
           7: Transmit 1800 Hz
           8: Transmit Preamble
           9: Transmit 100 Messages
          10: Test Marker Light
          11: Test Ram
          12: Test Rom
          13: Test Brake Valve Circuit
          14: Initiate Emergency Braking

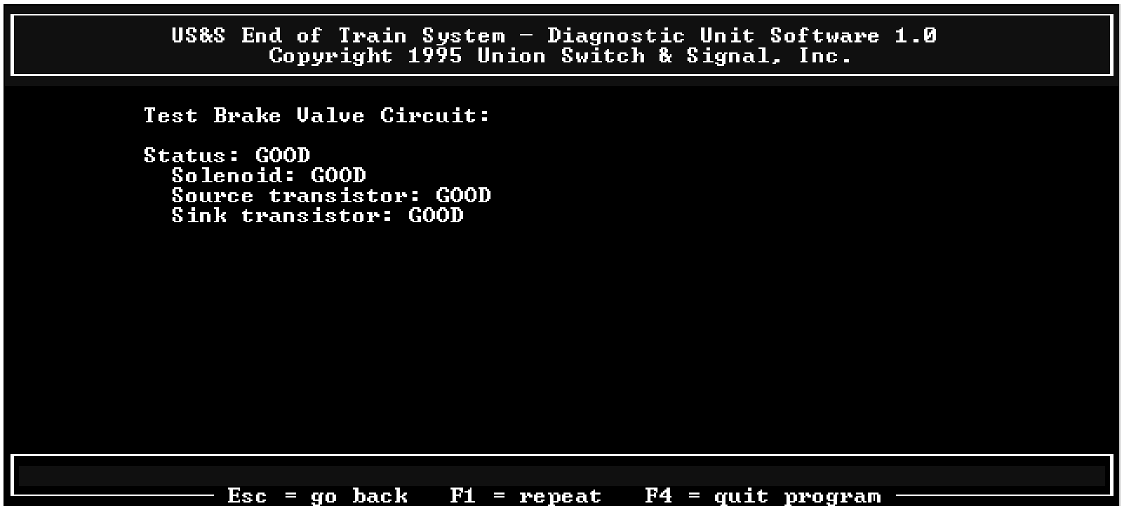
          Test Rom: GOOD

          Enter a menu item number:
            Esc = go back   F1 = repeat selection   F4 = quit program
```

The response, "GOOD" or "BAD", is relatively instantaneous. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.5.13 Test Brake Valve Circuit

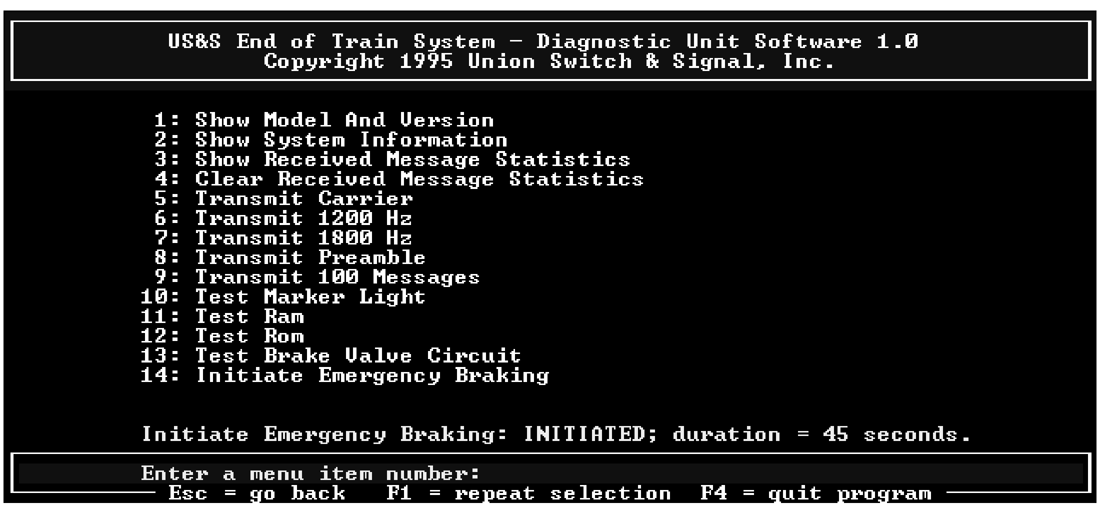
To initiate a test of the emergency brake solenoid, return to the Main Diagnostics Menu and type "13" (for “Test Emergency Brake Circuit”) and press **<Enter>**. The following screen showing the state of the solenoid and drive transistors will appear:



To return to the Main Diagnostics Menu, press **<Esc>**.

3.5.14 Initiate Emergency Braking

To initiate a test of the emergency braking function, return to the Main Diagnostics Menu and type "14" (for “Initiate Emergency Braking”) and press **<Enter>**. The following screen will appear:



The solenoid will open with an audible “click.”

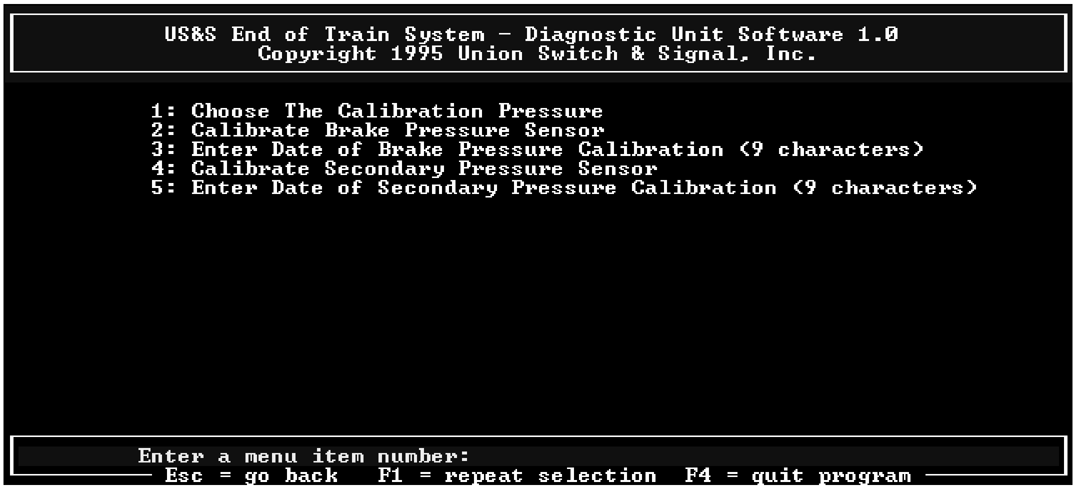
WARNING

If air pressure is connected to the glad-hand, it will be released to the atmosphere when the solenoid valve is opened. Use safety glasses and ear plugs when performing this step if air pressure is applied, otherwise personal injury may result!

After 45 seconds, the solenoid will close, again with an audible “click”. Press **<Esc>** to select another function or return to the Main Diagnostics Menu.

3.6 PRESSURE SENSOR CALIBRATION

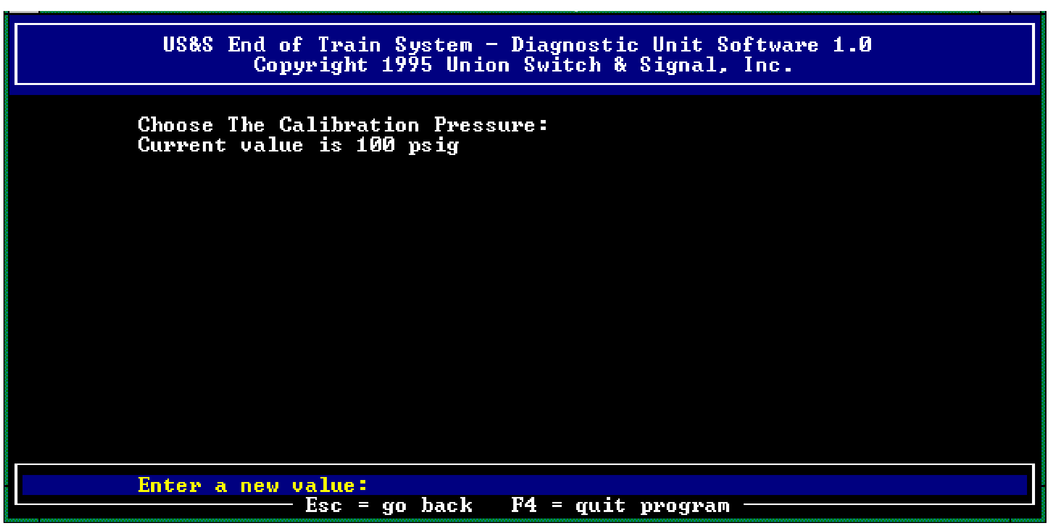
To initiate the Pressure Sensor Calibration function, return to the Main Menu, type "3" and then press **<Enter>**. The following screen will appear:



To calibrate the primary and optional secondary pressure transducers, perform the procedures described in the follow sections.

3.6.1 Choosing the Upper Pressure Setpoint

The brake pressure calibration technique performs a “zero and span” correction to ensure correct readings. The default upper limit for the “span” adjustment is 100 psig/690 kpa. However, some railroads have established calibration procedures that, while they still use 0 psig/kpa for the “zero” adjustment, use a different upper limit. To define an upper brake pressure limit other than 100 psig/690 kpa, type "1" (for “Choose the Calibration Pressure”) and press **<Enter>**. The following screen will appear:

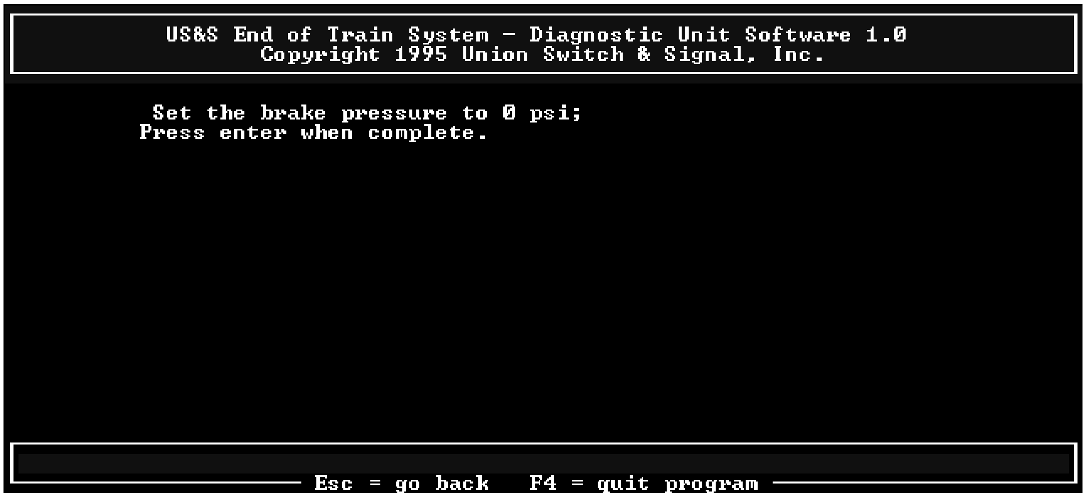


Enter a new value for the brake pressure calibration limit. For optimum calibration accuracy, it is recommended that if a value other than 100 psig/690 kpa is used, that the upper limit be set to 5 or 10 psi/35 or 69 kpa above the highest expected value of brake pressure. To return to the Main Calibration Menu, press **<Esc>**.

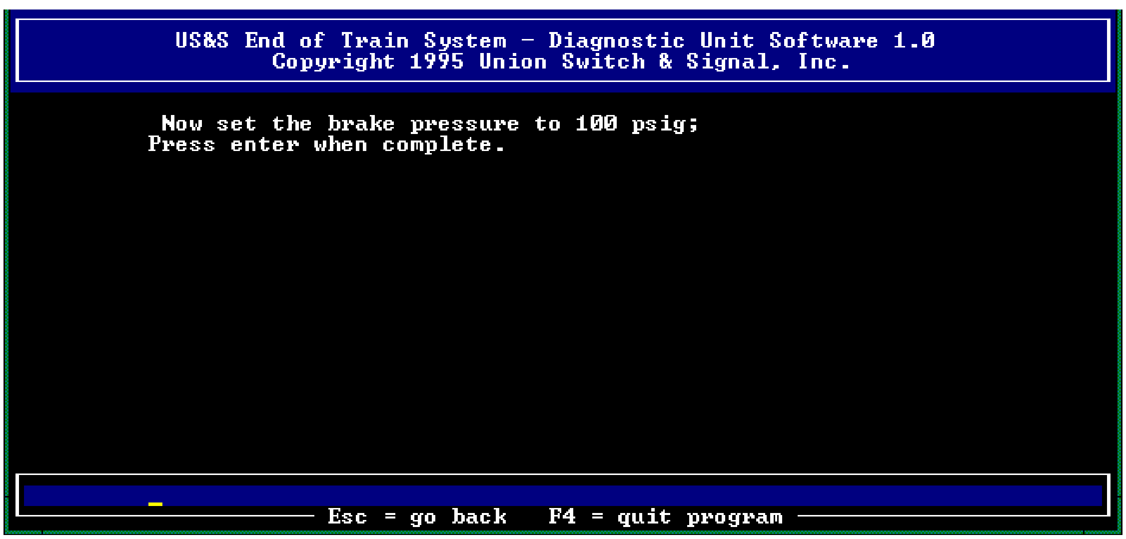
3.6.2   Calibrating the Brake Pressure Sensor

The SBU Model 6695-CC is designed to permit software calibration of the brake pressure sensor and its associated circuitry. To initiate brake pressure calibration, connect the glad-hand to a source of known air pressure.

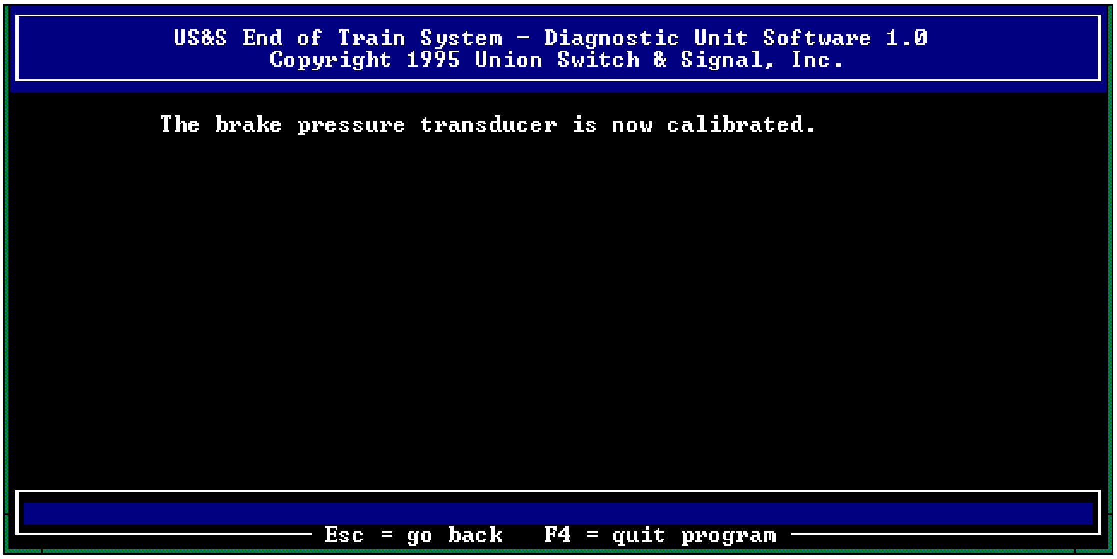
Return to the Main Calibration Menu and type "2" (for “Calibrate Brake Pressure Sensor”) and press **<Enter>**. The following screen will appear:



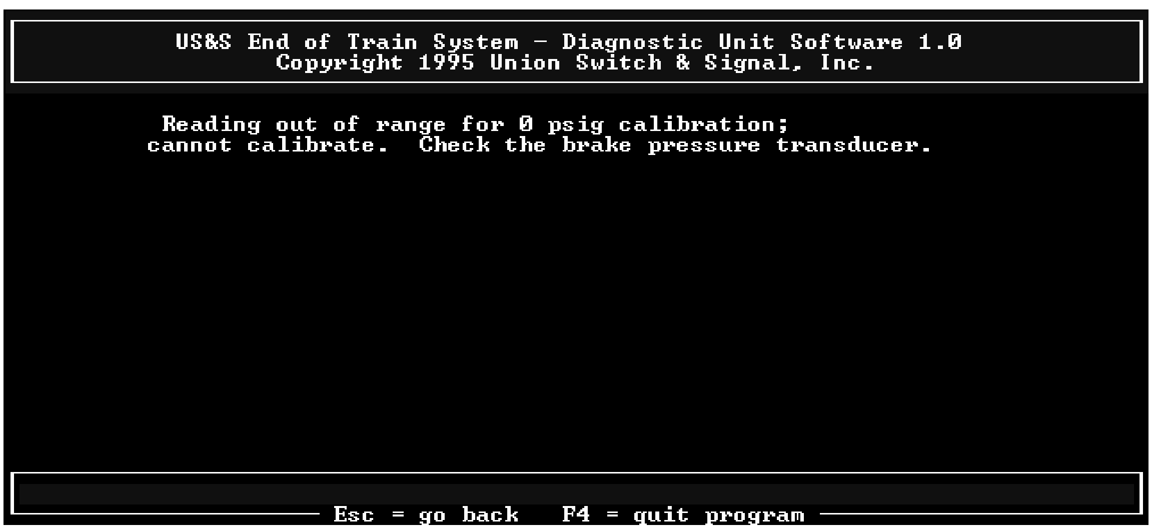
Set the air pressure attached to the glad-hand to zero; press **<Enter>** when this is done. The following screen will appear:



Set the air pressure to 100 psig/690 kpa (or to the indicated upper limit as was defined in “Choosing the Upper Brake Pressure Setpoint”) and press **<Enter>**. If the software calibration was successful, the following screen will appear:



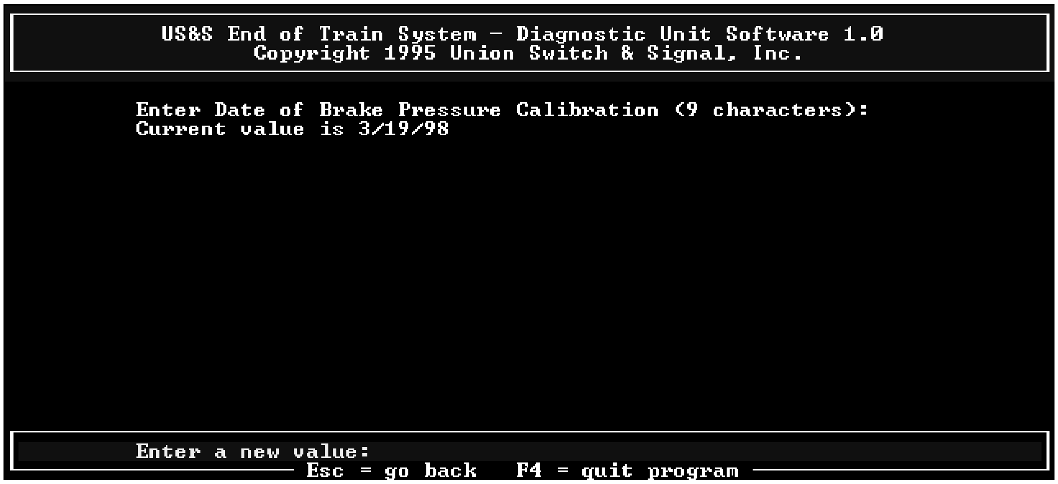
If the software calibration was unsuccessful, this screen will appear:



If this screen appears, the sensor or its associated circuitry is too far out of range for software calibration correction. In either case, to return to the Main Calibration Menu press **<Esc>**.

3.6.3 Recording the Brake Pressure Sensor Calibration Date

To record the brake pressure calibration date, return to the Main Calibration Menu and type "3" (for ("Enter Date of Brake Pressure Calibration"), and press **<Enter>**. The following screen will appear:



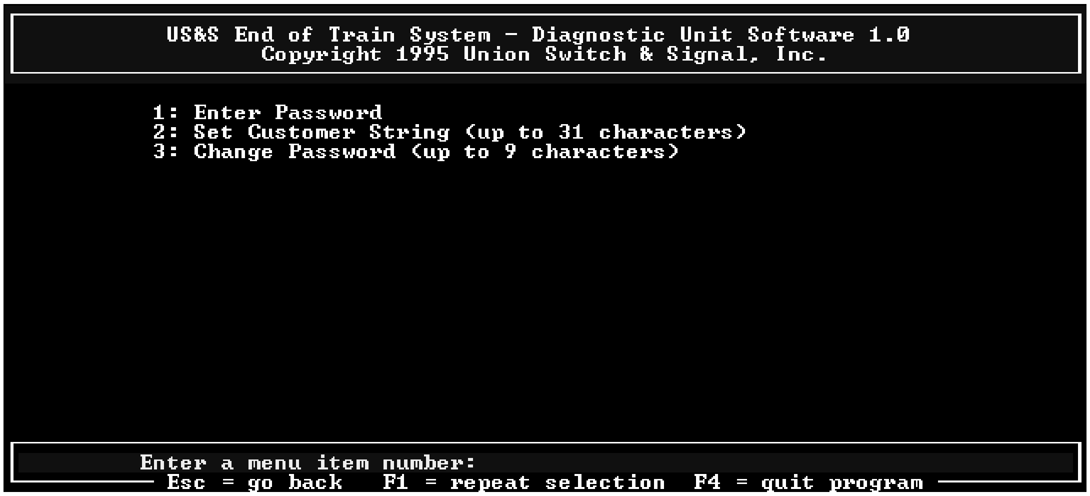
Enter the date in the form MM/DD/YY, where: MM = month, DD = day of month and YY = year. To store the date, press **<Enter>**; to return to the Main Calibration Menu, press **<Esc>**.

3.6.4 Calibrating the Secondary Air Pressure Sensor

Like the brake pressure calibration above, SBUs equipped with a secondary air hose can be calibrated in the same fashion.

3.7 SET PASSWORD PROTECTION SCREEN

This screen is displayed when “Password Protected Items” is selected from the Main Menu.



This menu changes the Customer String or enters a new password. The default password is set to “**US&S**” (unless otherwise specified by the customer).

NOTE

Once the password is changed, it is the responsibility of the railroad to remember the new password setting. If the password is forgotten, the Customer String cannot be changed, and the SBU or its Processor Board must be sent to US&S to default the password back to “US&S.”

The first item in the “Password Protected Items” menu is "Enter Password." This password must be correctly entered before the other two menu items can be accessed. The default password is “US&S” (unless otherwise specified by the customer).

Once the correct password has been entered, the user can perform the following two functions:

1. Enter or change the Customer String using the “Set Customer String (up to 31 characters)” menu.

2. Change the existing password using the “Change Password (up to 9 characters)” menu.

To return to the Main Menu, press **<Esc>**.

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4.0 CIRCUIT DESCRIPTION

This section provides a detailed circuit description of the various boards used in the SBU.

4.1 PROCESSOR BOARD

The Motorola 68HC16 microcontroller (U20) is a high speed 16-bit control unit with built-in Analog to Digital Converter (ADC) and 1 Kbytes of internal RAM. It was selected for use in the SBU Model 6695-CC because of its flexibility and low power consumption.

The SBU is designed for maximum battery life and minimum unit weight. Since power consumption is a prime consideration, a large percentage of the internal circuitry of the 68HC16 is turned off ("sleep mode") when not needed. It is turned on briefly only three (3) times per second for making measurements and for checking for incoming signals from the Cab Unit. Only the system clock and the internal timers keep running during these "sleep" periods.

4.1.1 EPROM Memory

The firmware for the SBU is stored in a 32 Kbyte EPROM (U22). Even though the power consumption for EPROM memory is lower than (for example) FLASH EPROM memory, in a low-power application such as this additional steps must be taken to reduce power consumption wherever possible. Since the vast majority of the power consumed by an EPROM occurs when it is accessed, placing the microcontroller into sleep mode also dramatically reduces the power consumed by the EPROM. A second 32 Kbyte EPROM (U21) has been included on the PC board for future expansion.

4.1.2 EEPROM Memory

The SBU ID code, all configuration perimeters, and calibration constants for pressure and temperature are permanently stored in a Serial EEPROM (U25). The SPI serial bus on the microcontroller is used for data transfers into and out of the EEPROM.

During the initialization operation when the SBU is powered up, these constants are loaded into RAM for quick access.

4.1.3 Expanded I/O

Although the 68HC16 microcontroller has a number of direct digital input and output pins, the SBU I/O requirements exceed the total available. Five additional ICs, two (2) octal input buffers (U14 and U15) and three (3) octal output latches (U16, U17 and U18) satisfy the I/O requirements.

4.1.4 Reset Function

The reset function is handled internally for the microcontroller. During the reset operation, the microcontroller checks the state of the data bus (D0 through D7) to determine configuration parameters. While reset is low, D0 is pulled low through Q11 to configure the controller for an eight-bit external data bus.

4.1.5 System Power-On Circuit

The power-on circuit utilizes a low power CMOS one-shot (U2 and its associated circuitry) that is triggered by either activation of the Brakeline Pressure Switch or the Test push-button. Power is temporarily applied to VBAT.SW (Q2) which powers the microcontroller through a low power voltage regulator for about 1/2 second. Once the microcontroller is up and running, the PWR.ON bit is set high to maintain power to the system through VBAT.SW. This allows the microcontroller to turn itself off when either brake pressure is removed for more then 5 minutes or battery voltage is drops below the cutoff threshold (as determined by the ADC).

4.1.6 Battery Latch Circuit

NOTE

For trouble-free operation, ensure that the batteries placed in the SBU are as fully charged as possible.

Depending on the configuration ordered, the SBU Model 6695-CC can use either Nickel-Cadmium (NiCad) or Lead Acid type batteries. Units using NiCad batteries are different from those using lead-acid style batteries in that, in deep discharge service, they exhibit an output voltage that remains “flat” for a much longer time. The voltage drops off very rapidly, however, when the battery is exhausted. With Lead Acid type batteries, the output voltage measurement under load provides a reasonably good indication of remaining charge.

On NiCad type units, to determine the state-of-charge, the microcontroller maintains a running calculation based on running time and ambient temperature to determine the state of the battery. To do this, it must be able to determine when a new battery, which it is assumes to be freshly charged, is installed in the unit. Whenever a new telemetry battery is installed, a CMOS Latching circuit (U7 and its associated circuitry) senses its presence and sets its output bit, TBAT.NW, low (U13, pin 8). This bit is read by the microcontroller each time it runs its power up initialization routine.

If TBAT.NW, is low during initialization, the microprocessor sets the battery state-of-charge to 100% and the SET.BAT (U18, pin 12) output bit high, briefly, to reset the battery latch. The battery latch will not change state again until the battery is removed and replaced. If an old battery is installed by mistake, the state-of-charge calculation will be incorrect. However, since the battery voltage measurement takes precedence over the battery status counter, the dropping battery voltage will be detected and transmitted to the Cab Unit.

If TBAT.NW is high during initialization, it is assumed the same battery is in the unit and the micro-controller will resume the battery charge calculations based on the most recently saved battery state.

Three battery configuration jumpers, named BATOPT0 through BATOPT2 located on the interface board in the battery compartment, are read by the microcontroller during initialization so that the proper discharge rate can be applied to the calculation. See the SBU Model 6695-CC Installation and Operation Manual (SM 7065) for information on the positions of the 3 jumpers

4.1.7 Expansion Port

The microcontroller PC Board is equipped with an expansion port (J13) that will permit future hardware expansion. Additionally, it provides access to the Address and Data buses for debugging Voltage Regulation and Power Management Circuits

There are a number of voltage regulators and switched power sources within the SBU, as described in the following paragraphs.

4.1.8 Microcontroller Power Supply - V_{CC}

This regulator (U10) supplies the 5 volts for the digital circuits.

4.1.9 Analog Power Supply - V_{ANALOG}

This regulator (U4) is controlled by the microcontroller output bit, ANLG.PWR (U16, pin 13). When the bit is set high, seven (7) volts are applied to the analog circuits. Some of these analog circuits are switched off when not in use by microcontroller output bits to further reduce power consumption.

4.1.10 Pressure Transducer Power Supply - V_{PTD}

A second voltage regulator (U9) is also controlled by the ANLG.PWR bit. It provides the voltage source for the VREF.1 generator (U3) and the Pressure Transducer.

4.1.11 Pressure Transducer Power Switch - Q10

Power is applied to the Pressure Transducer when the ANLG.PWR bit is set, as described in Section 4.1.9. However, the transducer is not enabled until the PTD.PWR (U16, pin 12) bit is set providing a ground path for the transducer. Once the PTD.PWR bit is set and the appropriate stabilization (approximately 15 msec) time has passed, the output of the Pressure Transducer is measured by the ADC and then turned off until it is needed again.

4.1.12 Modem Power Supply - V_{MODEM}

This regulator (U8) is controlled by the microcontroller output bit, TRAN.PWR (U16, pin 15). When this bit is high, seven (7) volts are applied to the modem op-amps (U5 and U6).

4.1.13 Radio Power Switch - V_{TRANS} Supply

Power MOSFETs Q8 and Q9 are also controlled by the TRAN.PWR (U16, pin 15) microcontroller output bit. When TRAN.PWR is set high, power is applied to the transceiver via voltage regulator U11.

4.1.14 Voltage References

VREF.1, produced by U3, is a 5.0 volt level used to scale the microcontroller's internal 10 bit ADC converter.

VREF.2, produced by U5, is a 2.5 volt level used as the virtual ground for the modem receiver circuit. It is set at one-half the full scale value of the ADC, so that only a single-sided supply is required. These references are related so that if VREF.1 drifts, the analog signals used to generate VREF.2 will drift with respect to VREF.1, thus reducing the conversion errors.

4.1.15 Diagnostics Port Power Supply

While there is no external regulator or switch for the diagnostics port RS-232 driver chip (U1), power to this circuit is controlled by the microcontroller.

When the RS-232 port is not in use, the receive line is pulled high with a pull-up resistor causing the DIAG bit (U13, pin 6) to be pulled low. When a host computer is connected to the Controller PCB, the receive line sees a steady mark condition (approximately -12 volts). This forces the DIAG bit high to indicate the presence of the diagnostics PC.

The DIAG bit is polled whenever the test push-button is pressed. If the DIAG bit is high, the DIAG.PWR (U17, pin 13) bit is set applying power to the RS232 interface chip. The DIAG.PWR bit will be cleared by removing the host computer from the diagnostics port. To get out of test mode it is necessary to again press the test push-button.

4.2 ANALOG CIRCUITS

4.2.1 Detection Of Transmission From Cab Unit

On 330 millisecond intervals, the SBU checks to see if a Front-to-Rear transmission is present. Power is applied to the transceiver by setting the TRAN.PWR bit high and testing the RADIO.CD (U14, pin 5) bit to determine if a carrier is present.

4.2.2 Receiving Data

Power is applied to the required circuits for the receive operation. The radio squelch is disabled by setting the SQ.DIS (U16, pin 17) bit low. Note that radio squelch can be disabled if desired. See Service Manual SM 7065.

4.2.3 Transmitting Data

Five microcontroller output bits (U20, pins 72 through 76) and a resistor network (R51, R82, R83, R84, R85, R86, R50) form a rudimentary, five-bit digital to analog converter to generate the modem audio output tones. Predetermined values from a lookup table are written sequentially to the five-bit output bits on fixed time intervals to synthesize the modem tones. The synthesized audio is scaled and filtered (U5 and U6) to smooth out the waveform. The output bits are set low when not in use to minimize the inactive currents flowing through the resistor network.

4.2.4 Brake Pressure Circuit

There is no analog circuitry required to scale the pressure transducer. The output of the transducer is 0.5 to 4.5 volts corresponding to a 0 to 150 psig range. Any values outside this range will indicate a faulty pressure transducer. The output yields 5.46 ADC counts per psi. To minimize power consumption, the pressure transducer has an FET Switch controlled by PTD.PWR (U16, pin 12). About 15 milliseconds are required for stabilization between when the transducer is turned on and when readings can be taken.

4.2.5 Temperature Circuit

The ambient temperature is measured by a Dallas Semiconductor DS1620 IC (U12) and transferred by way of a two-wire synchronous serial bus to the microcontroller.

4.2.6 Battery Circuit

Since the actual battery voltage is well above the maximum input range of the ADC, the battery circuit provides an output proportional to exactly one third of the battery voltage. To take a battery voltage measurement the BAT.TEST bit (U17, pin 16) must be set high. This activates the low impedance divider network to load the battery. After the battery measurement is complete, the BAT.TEST bit is returned low to minimize the inactive current flowing through the divider network.

4.3 MARKER LIGHT CONTROL (MTEST AND MFLASH)

There are two control bits that allow the programmer to operate the Marker Light manually. When the MTEST (U17, pin 17) bit is set high, battery voltage is applied to VBAT1.SW. This applies power to the Marker Light circuits regardless of brake pressure and tilt switch positions. When the MFLASH (U17, pin 18) bit is then set high, the Marker Light will flash regardless of ambient light conditions. These control lines make it possible for the microcontroller to perform a Marker Light test when the test push-button is pressed or when the train starts to move.

4.4 EMERGENCY BRAKE VALVE CONTROL

4.4.1 Solenoid Activation

There are two MOSFET switches (Q14 and Q16) that must be set in order to activate the emergency brake solenoid. To activate the solenoid EBRAKE1 (U16, pin 18) is set high and EBRAKE2 (U16, pin 19) is set low. The two opposite states are used to prevent the brake solenoid from inadvertently activating during power up or power down, due to both bits achieving the same state or in the event of a failure in one of the MOSFETs.

4.4.2 Solenoid Activation Confirmation

To confirm that the solenoid coil has been activated, there are two comparators that provide the necessary status bits that must be checked by the microcontroller. The following describes the state of each bit while the solenoid is activated:

SOL.ON	OVER.C	Current flowing through solenoid
Logic “0”	Logic “0”	i > 1.4 A → “shorted coil”
Logic “0”	Logic “1”	1.4 A > i >300 ma → “normal on”
Logic “1”	Logic “0”	impossible case
Logic “1”	Logic “1”	i <300 ma → “normal off”

SOL.ON is located at U23, pin 13, OVER.C is located at U23, pin 14.

Table 4.1 - Solenoid Activated Bit Status

4.4.3 Testing

To test the “health status” of a solenoid and proper operation of the switching circuit, a biasing resistor (R75) is used in conjunction with the two voltage dividers that will apply one-half V_{BAT} to the emergency brake solenoid. This voltage allows the brake solenoid circuit to be tested without actually activating the solenoid by turning on the sinking and sourcing MOSFETs one at a time and checking the voltage present on both sides of the solenoid.

4.4.4 Testing the Sinking MOSFET (Q16)

1. EBRAKE1 (U16, pin 18) is set low and EBRAKE2 (U16, pin 18) is set high - SBRAKE2 (U23, pin 2) bit must produce a logic high.
2. The EBRAKE2 bit is then set low. The voltage present on the positive side of the solenoid will be pulled to ground. SBRAKE2 must produce a logic low, indicating that the voltage dropped below approximately 5.1 volts.

If the two conditions above are met, then the Sinking MOSFET (Q16) and the solenoid are good.

4.4.5 Testing the Sourcing MOSFET (Q14)

1. EBRAKE1 (U16, pin 18) is set low and the EBRAKE2 (U16, pin 18) is set high - SBRAKE1 (U23, pin 1) must produce a logic high.
2. The EBRAKE1 bit is then set high. The voltage present on the negative side of the solenoid will be pulled to VBAT.SW. SBRAKE1 must produce a logic low, indicating that the voltage rose above approximately 9.9 volts.

If the two conditions above are met, then the Sourcing MOSFET (Q14) and the solenoid are good.

A divider network (R7, R68, R69, R70 and R71) is used to provide the reference voltages to the comparators used for both verification and testing of the emergency brake solenoid.

4.4.6 Interface Board

The Interface Board, mounted inside of the battery compartment, plugs into the Microcontroller Board to carry the battery, battery configuration jumper and diagnostic port leads through the intercompartmental wall into the telemetry compartment. The shared/unshared battery jumper, the fuses and isolation diodes also reside on this board.

4.4.7 Display Board

The Display Board is a small PC board that is mounted on standoffs to place it closer to the LED display window on the side of the SBU near the handle. It contains the LED Display and the photocell (PH1) for monitoring the ambient light level for Marker Light control.

4.5 MARKER LIGHT BOARD

4.5.1 Optical and Mechanical Details

The SBU Marker Light uses an array of 144 red or amber "super-bright" LEDs, arranged in a square matrix pattern as its light source. The LEDs are placed vertically on the printed circuit board to eliminate the need for aligning, adjusting or directing of the LEDs during manufacturing or repair.

A special lens with individual “pillows” is placed in close proximity to the LEDs to disperse the inherently circular pattern, primarily in the horizontal direction to meet the requirements set forth by the Federal Railroad Administration for a minimum light intensity of 100 candela on center and 50 candela at $\pm 5^\circ$ vertically and at $\pm 15^\circ$ horizontally from center.

4.5.2 Marker Light Operation

The operation of the Marker Light is enabled by the activation of a pressure switch connected to the brakeline of the train. Once the brakeline pressure has been applied, the Marker Light will continue to operate after brakeline pressure has been removed, until such time as the battery is removed.

The Marker Light is designed to work with a photocell (PH1) that is mounted on the elevated Display Board. The photocell and its associated circuitry enable the flashing of the Marker Light when the ambient light drops below the ambient light level set forth by the Federal Railroad Administration.

A tilt switch (SW1) has been incorporated onto the Marker Light board so that once the Marker Light has been removed from the train and tilted the Marker Light will automatically turn OFF. Brakeline pressure must be removed before the tilt switch is enabled to turn off the Marker Light. This ensures that the Marker Light will not be effected by vibration.

4.5.3 Electrical Description

The Marker Light Board includes the circuits described in detail in the following paragraphs.

4.5.3.1 Power ON/OFF Circuit

The Power ON/OFF Circuit consists of two NAND gates (U2) configured as a set/reset flip-flop. In normal operation, the MLATCH signal from the Microcontroller Board forces pin 11 of U2 to latch high applying power, VBAT1.SW, to the Ambient Light Sensing Circuit via Q1 and Q2. Once latched, the flip-flop can only be reset by either tilting the Marker Light or by removing power. MLATCH, although partially derived from the pressure switch, is used instead of a direct pressure switch input to permit the user to force the Marker Light on for marking railcars set out on sidings at night without air pressure.

For test purposes, the MTEST signal from the Microcontroller Board, will also turn on VBAT1.SW for the period of time that it is asserted high. To flash the Marker Light for test purposes, MFLASH must also be asserted high to simulate a low ambient light level.

If the battery voltage drops below a preset value (approximately 9.5 volts at the battery terminals or approximately 9.0 volts at the board, allowing for isolation diode drops), the low battery shutdown sensor (U3) resets the Power ON/OFF flip-flop, turning the Marker Light power off to prevent damage due to battery cell reversal.

4.5.3.2 Ambient Light Sensing Circuit

The Ambient Light Sensing Circuit is a comparator circuit (U4) that applies power to the flash oscillator and LED driver circuits once ambient light drops below a given level. The circuit has hysteresis built-in to prevent output jitter when light levels approach the Marker Light's ambient light set point.

The MFLASH signal from the Microcontroller Board will simulate a low ambient light level for test purposes by turning on VBAT3.SW for the period of time that it is asserted high (MTEST must also be asserted high).

4.5.3.3 Flashing Circuit

The flasher circuit utilizes a “555” style timer chip (U5) to establish the frequency and duty cycle of the Marker Light (100 msecs. on and 900 msecs. off). The output of the timer drives the LED driver (Q6) to turn Marker Light LEDs on and off. When the LEDs are “supposed” to be on, MOSFETs Q7 and Q8 produce a low true signal, HVM.ON. This signal is used in conjunction with the Fault Detection Circuit described below to verify that the LEDs are actually on. The HVM.ON signal causes an interrupt request (IRQ1) each time the light is turned on. The interrupt service routine reads the Marker Light current and based on pre-defined limits determines the status of the Marker Light LEDs.

4.5.3.4 Fault Detection Circuit

The total current for all the LEDs is determined by measuring the voltage drop across R37. This voltage is expanded by U1 to improve the ADC accuracy. R47 and D38 are used to limit the maximum output voltage to protect the ADC. C6 is used to dampen the output signal to ensure that the average current is measured.

Both open and shorted LEDs can be detected by measuring the total current flow and comparing it to preset limits.

5.0 PERIODIC MAINTENANCE CHECKS AND SERVICES

The following schedule is a guideline for periodic maintenance on the SBU Model 6695-CC. The following recommended checks should be performed as indicated.

TYPE OF TEST	RECOMMENDED SCHEDULE	SERVICE MANUAL REFERENCE
External	As required for performance verification after repair or any time.	SM 7066, Section 2.3
External	Every 3 months	SM 7066, Section 2.3
Pressure measurement circuitry calibration	Every 6 months	SM 7066, Section 3.6
Radio power and center frequency calibration	Every 6 months, or at least once per year per FRA requirements.	SM 7066, Section 2.6.4
Emergency Valve Inspection and Test	Every 6 months	SM 7066, Section 2.6.3
Radio alignment (SBU and Cab Unit), SBU measurement circuitry calibration	Once per year per FRA requirements.	SM 7066, Section 2.6.4

Table 5.1 - Periodic Maintenance Checks and Services

5.1 BATTERY REPLACEMENT

Depending on the configuration ordered, the SBU Model 6695-CC can use up to two NiCad rechargeable batteries or a single Lead Acid-type battery. The SBU consumes a minimum of DC power, thus maximizing battery-replacement cycles.

5.1.1 NiCad Battery Replacement

To replace the NiCad-style battery, follow these steps:

1. Release the retaining latches on the battery compartment door and open it.
2. Remove the retaining nut(s) holding the battery in place. Remove the used battery from the compartment. Recharge each used NiCad battery as required.
3. Align the hole of the replacement battery with the post in the battery compartment.
4. Place the replacement battery onto the post and tighten the retaining nut <u>all the way</u> until the battery is secure. Do not overtighten.
5. Close and secure the battery door with the retaining latches.

5.1.2 Lead Acid Battery Replacement

The SBU version supporting the Lead Acid-type battery contains a battery compartment that holds one Lead Acid rechargeable battery.

To remove the battery, grip the battery enclosure and pull it out of the compartment.

To install the battery, slide it into the compartment so that it mates with the internal power connector.

5.2 FUSE REPLACEMENT

If the system processor, radio, or marker light fails, remove the fuse cover to gain access to the fuse panel. Check the following fuses and replace with 2 Amps, as required.

Fuse	Fuse Function
F1	Processor Power
F2	Transceiver Power
F3	Marker Light Power

Table 5.2 - Fuse Functions

5.3 CLOSED CASE PRESSURE SENSOR CALIBRATION

The Closed Case Calibration function eliminates the need of opening the case for recalibration of the pressure transducer(s) and associated circuitry (usually every 90 days).

During the regular 90-day check, the calibration technician connects a personal computer loaded with diagnostic software to the RS-232 diagnostic port within the battery compartment and applies known air pressure to the SBU. If the error between the applied pressures and the measured values exceed the maximum permitted error, the technician may elect to do a software recalibration for the SBU. In this process, the PC compares the known and measured values and uploads corrected, calibration information to the parameter storage EEPROM in the SBU. If during the Closed Case Calibration check the calibration is determined to be outside of preset boundaries, this may indicate a problem with the electronics for the pressure transducer. The technician will be informed and recalibration will not be allowed.

For full instructions on how to perform Closed Case Calibration, refer to Section 3.6.

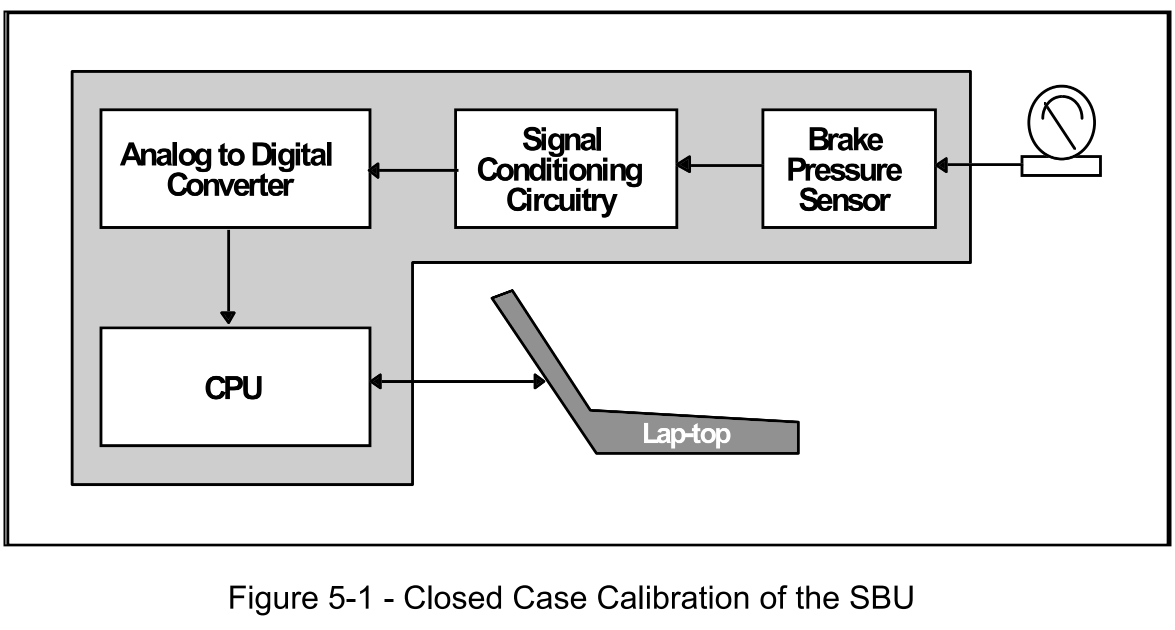


Figure 5-1 - Closed Case Calibration of the SBU

5.4 MOTOROLA TRANSCEIVER MODULE DIP SWITCH SETTINGS

When making adjustments or installing a new Transceiver Module of the Motorola type into the SBU, verify that its internal DIP switch settings are as follows:

NOTE

Incorrect DIP Switch settings will cause the Transceiver to operate intermittently.

	1	2	3	4	5	6	7	8
ON				●		●	●	●
OFF	●	●	●		●			

Table 5.3 - Motorola Transceiver Module DIP Switch Settings

5.5 ADJUSTING MARKER LIGHT AMBIENT LIGHT SENSING CIRCUIT

Trimpot R66, located on the Marker Light PCB Assembly, is used to adjust the ambient light threshold. This trimpot is accessible by removing the SBU's back cover and is located at the bottom of the Marker Light Board below the Motion Detector Module.

NOTE

Trimpot R66 is factory calibrated for a specific light threshold and sealed. It should typically NOT require adjustment.

In the event that maintenance on the SBU involves the replacement of components on the Marker Light Board, the replacement of the four-character LED display board, or the photocell on the LED display board, trimpot R66 can be used to readjust the ambient light sensitivity.

To perform this adjustment, select the PHOTOCELL function using the SBU's TEST button as described in the "Unit Testing" Section in Service Manual 6496 (SM 6496). Simulate dusk or dawn ambient light conditions by placing an appropriate light source (e.g., a flashlight with diffused lens) directly against the display window. Since the SBU's back cover is removed, ensure that other light sources (i.e., bench lamp, sunlight, etc.) do not interfere with the adjustment. Turn trimpot R66 in the **clockwise** direction to **reduce** the sensitivity; turn trimpot R66 in the **counter-clockwise** direction to **increase** the sensitivity. The HVM Light will flash, or not flash, accordingly. When the adjustment is complete, reseal trimpot R66.

5.6 OPERATIONAL TEST CHART

The following chart provides a step-by-step rapid operational check of the SBU, including adjustment information on the trimpots located on the Processor Board. The chart may be used by a radio shop technician as a test check-off sheet.

Operation	Stimulus	Value	Tolerance	Comments	Technician's Initials
Power-up test	Press and hold test button until the word "TEST" appears, then release	---	---	The display should indicate: Customer User String ("US&S" by default), Software Rev. #, Battery Condition and Brake Pressure. Marker should flash several times and then stop. The LED display will go dark after displaying the brake pressure for 30 seconds (default, configurable).	
Pressure Initiated Power-up	Apply brake pressure > 10 psig	---	---	The display should indicate: Customer User String ("US&S" by default), Software Rev. #, Battery Condition and Brake Pressure. Marker should flash several times and then stop. The LED display will go dark after displaying the brake pressure for 30 seconds (default, configurable). If ambient light levels are below the threshold, Marker will begin flashing again when display goes dark.	
Pressure Initiated Shutdown	Remove brake pressure	---	---	The unit should continue to operate for 5 minutes before powering down. Power consumption should be < 3 ma (after power down)	
Brake Pressure Calibration Step 1	Use Diagnostic PC to select "Enter Date of Brake Pressure Calibration"	---	---	If calibration is outdated, proceed with the rest of the calibration.	
Step 2	Use Diagnostic PC to select "Calibrate Brake Pressure Sensor". Apply air pressure of 0 psig. Press "Enter"	---	---		
Step 3	Apply air pressure of 100 psig Press "Enter"	---	---	If successful, select "Enter Date of Brake Pressure Calibration" and enter date. If unsuccessful, abort the remainder of the test.	
Brake Pressure Calibration Verification Step 1	Apply air pressure of 0 psig Press and hold test button until the word "PRESSURE" appears, then release	0 psig	-0, + 3 psig	Read the brake pressure on the LED display. If out of spec., abort the remainder of the test and check transducer.	
Step 2	Apply air pressure of 50 psig	50 psig	± 3 psig	Read the brake pressure on the LED display If out of spec., abort the remainder of the test and check transducer.	
Step 3	Apply air pressure of 100 psig	100 psig	± 3 psig	Read the brake pressure on the LED display If out of spec., abort the remainder of the test and check transducer.	
Low Battery Test Step 1	Apply input voltage > 12 VDC Press and hold test button until the word "PRESSURE" appears, then release.			Cab Unit should have no indication of low battery. J1 jumper in "shared" position.	
Step 2	Slowly reduce battery voltage until the Cab Unit indicates "Weak Battery"	Supply voltage = 11.8 v	± .1 v		
Step 3	Slowly reduce battery voltage until the Cab Unit indicates "Replace Battery"	Supply voltage = 10.8 v	± .1 v		
Step 4	Reduce battery voltage to 9.3V Press and hold test button until the word "TEST" appears, then release.		-.1, +0 v	End Unit indicated battery condition is "ABORT." End Unit will power down.	

Table 5.4 - Operational Tests - All Units

Operation	Stimulus	Value	Tolerance	Comments	Technician's Initials
Brake dump test Step 1	Pressurize a ~12 gallon tank to 50 psig. Remove air supply and connect the tank to the End-Unit glad-hand			Remove the input voltage, return it to > 12 VDC and reapply it. Exhaust valve should close within 3 seconds. **Use Ear and Eye Protection!**	
Step 2	Trip Cab Unit Emergency Brake Switch			Exhaust valve should open and vent the tank to < 10 psig within 5 seconds. **Use Ear and Eye Protection!**	
Step 3	Wait for the End Unit solenoid to close (25 to 45 seconds)			Pressure in tank should be < 4psig.	
Step 4	Press "Comm Test" button on Cab Unit			Cab-Unit should display 0 psig.	
Marker Light Sensor Test	Press and hold test button until the word "PHOTOCELL" appears, then release.			The Marker Light should flash when the ambient light is below the threshold and stop flashing when the ambient light is above the threshold.	
Motion Detector Test Step 1	Apply air pressure of 50 psig Press and hold test button until the word "PRESSURE" appears, then release. Leave the End Unit motionless for 2 minutes.			Verify that the Cab-Unit indicates "STOPPED"	
Step 2	Lean the End-Unit towards the Marker Light			Verify that the Cab-Unit indicates "FORWARD." The Marker Light should flash 5 times and then stop.	
Step 3	Within 5 seconds, lean the unit away from the Marker Light			Verify that the Cab-Unit indicates "REVERSE".	
Step 4	Rock the End Unit gently back and forth for 20 seconds.			Verify that the Cab-Unit indicates "MOVING."	
Step 5	Leave the End-Unit motionless for 30 seconds			Verify that the Cab-Unit indicates "STOPPED."	
Step 6	Lean the End-Unit away the Marker Light			Verify that the Cab-Unit indicates "REVERSE." The Marker Light should flash 5 times and then stop.	
Step 7	Within 5 seconds, lean the unit towards from the Marker Light			Verify that the Cab-Unit indicates "FORWARD."	
Step 8	Rock the End-Unit gently back and forth for 20 seconds.			Verify that the Cab-Unit indicates "MOVING."	
Step 9	Leave the End-Unit motionless for 15 seconds			Verify that the Cab-Unit indicates "STOPPED."	

Table 5.4 (Continued) - Operational Tests - All Units

WARNING

Ensure that the Transceiver's antenna output is connected to an antenna, RF Monitor, or 50 ohm dummy load when initiating transmissions. Lack of an RF load can cause overheating of the transmitter and eventual failure.

Operation	Stimulus	Value	Tolerance	Comments	Technician's Initials
Transmit RF Power	Use Diagnostic PC to transmit un-modulated carrier	2 watts	+0 w, -.25 w	Use R62 on main board to adjust, if adjustment is made, "re-lock" R62 with Glyptol or equivalent.	
Transmitter Center Frequency	Use Diagnostic PC to transmit un-modulated carrier	457.9375 MHz *(See Table 2.4 for other Freq's)*	± 2.29 KHz	If out of spec., correct by adjusting coil L101, in the radio. This adjustment should be set for ± 200 Hz at room ambient temperature (see Note 1 below)	
Receiver Center Frequency	Use Diagnostic PC to select any "non-transmit" mode	407.9375 MHz (LO Freq) *(See Table 2.4 for other Freq's)*	± 4.53 KHz	Measure local oscillator leakage using a Communications Monitor (452.9375 MHz - 45 MHz IF Frequency) **Use TX Inhibit Adapter to protect Monitor.** If the reading is out of tolerance, return the transceiver to US&S.	
Transmitter Deviation	Use Diagnostic PC to transmit "preamble"	3.0 KHz	± 100 Hz	Use R50 on main board to adjust, if adjustment is made, "re-lock" R50 with Glyptol or equivalent.	

Table 5.5 - Quick Radio Calibration Chart
For SBUs Equipped with Motorola RNET 450 Transceiver

Operation	Stimulus	Value	Tolerance	Comments	Technician's Initials
Setting Receive Audio Levels step 1	Input 452.9375 MHz, -60 dBm, FM Modulated 1200 Hz tone, 3.0 KHz Deviation. Use Diagnostic PC to select any "non-transmit" mode. *(See Table 2.4 for other frequencies)*	4.0 v p-p	± .1 v	Measured at J7, using the Radio Test Cable. Use R43 on main board to adjust, if adjustment is made, "re-lock" R43 with Glyptol or equivalent.	
step 2	Input 452.9375 MHz, -60 dBm, FM Modulated 1800 Hz tone, 3.0 KHz Deviation. Use Diagnostic PC to select any "non-transmit" mode. *(See Table 2.4 for other frequencies)*	4.0 v p-p	- .3 v, +.5 v		
Measure Receive Sensitivity (SINAD)	FM Modulated RF Generator set to RF Output Freq = 452.9375 MHz; RF Output Level = -50 dbm; Modulation = 1 KHz Sinewave, Deviation = 3.0 KHz *(See Table 2.4 for other frequencies)*	0.4 µV max (-115 dbm) at -12 db Sinad		If sensitivity is greater than 0.4 µV, replace transceiver.	

Table 5.5 (Continued)- Quick Radio Calibration Chart
For SBUs Equipped with Motorola RNET 450 Transceiver

NOTE

1. When adjusting the transmitter center frequency, check for frequency drift over a period of several minutes. Check this by using the Diagnostics PC to key the radio for a short time (e.g., 5 seconds) for each check. It is NORMAL for a good radio to drift slightly (e.g., ± 1000 Hz). If the radio continues to drift outside the Tolerance value listed in the chart above, it should NOT be put into operating service.

Operation	Stimulus	Value	Tolerance	Comments	Technician's Initials
Transmit RF Power	Use Diagnostic PC to transmit unmodulated carrier	2 watts	+0 w, -.25 w	Use R62 on main board to adjust, if adjustment is made, "re-lock" R62 with Glyptol or equivalent.	
Transmitter Center Frequency	Use Diagnostic PC to transmit unmodulated carrier. *(See Table 2.5 for other frequencies)*	457.937 5 MHz	± 675 Hz	If the reading is out of tolerance, return the transceiver to US&S.	
Transmitter Deviation	Use Diagnostic PC to transmit "preamble". For all transceivers except Australian version (P/N: N24600009): Australian version (P/N: N24600009):	 3.0 KHz 2.0 KHz	± 100 Hz	Use R50 on main board to adjust, if adjustment is made, "re-lock" R50 with Glyptol or equivalent.	
Setting Receive Audio Levels (Except Australian version p/n: N24600009)	Input 452.9375 MHz, -60 dBm, FM Modulated 1200 Hz tone, 3.0 KHz Deviation. Use Diagnostic PC to select any "non-transmit" mode. *(See Table 2.5 for other frequencies)*	0.3 Vp-p to 1.2 Vp-p		Measured at J7, using the Radio Test. Use R43 on main board to adjust, if adjustment is made, "re-lock" R43 with Glyptol or equivalent.	
Setting Receive Audio Levels (Australian version p/n: N24600009)	Input 472.500 MHz, -90 dBm, FM Modulated 1500 Hz tone, 2.0 KHz Deviation. Use Diagnostic PC to select any "non-transmit" mode.	0.3 Vp-p to 1.2 Vp-p		Measured at J7, using the Radio Test. Use R43 on main board to adjust, if adjustment is made, "re-lock" R43 with Glyptol or equivalent.	
Measure Receive Sensitivity (SINAD)	FM Modulated RF Generator set to RF Output Freq = 452.9375 MHz; RF Output Level = -50 dbm; Modulation = 1 KHz Sinewave, Deviation = 3.0 KHz (2.0 KHz for Australian radio)	0.4 μV max (-115 dbm) at -12 db Sinad		If sensitivity is greater than 0.4 μV, replace transceiver.	

Table 5.6 - Quick Radio Calibration Chart
For SBUs Equipped with Johnson Data Telemetry Transceiver

A.1 COMPOSITE SBU (NICAD BATTERY) - GRAY, SMALL HOSE, QUICK EXHAUST VALVE (PN: N26301501)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Gray	N26301402	1
10	Electronics Cage Assy	N24600204	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Gray	M26300302	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
120	Support, Chain Hose	408-0735-00	1
125	Valve - Quick Exhaust	J3373850002	1
130	Hose, 27” LG with 1/4 M Swivel	J0327600026	1
135	Washer - 5/8” Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	7
205	Tag, Batt Shadow	J0759750031	1
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1
305	Washer	M334674	4
310	Cotter, 3/32 x 3/4 SST KKT	J048689	1
315	Foam Cushion	M24606303	1

A.2 COMPOSITE SBU (NICAD BATTERY) - GRAY, IN-LINE EXHAUST VALVE (PN: N26301502)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Gray	N26301402	1
10	Electronics Cage Assy	N24600204	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Gray	M26300302	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
135	Washer - 5/8" Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	7
160	Cable - Gal Steel 26" Long	J0702050630	1
165	Valve, In-Line Quick Exhaust	J7924260017	1
170	Nipple - 1/4 NPT SS	J79242600015	1
175	Air Hose Assy	J0327600050	1
205	Tag, Batt Shadow	J0759750031	1
250	Screw - 10-32 x 5/8 SOC	J5001240004	2
255	Washer, 10 Plate SST	J4751200110	2
260	Washer - SST Lock No 10	J4751210109	2
265	Bracket, Hose Support	N26301902	1
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1
305	Washer	M334674	4
310	Cotter, 3/32 x 3/4 SST KKT	J048689	1
315	Foam Cushion	M24606303	1

A.3 COMPOSITE SBU (NICAD BATTERY) - YELLOW, SMALL HOSE/QUICK EXHAUST, (PN: N26301503)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Yellow	N26301404	1
10	Electronics Cage Assy	N24600206	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	2
50	Washer - SST .144 ID Flat	J4751210128	6
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
65	Screw - SST 4-40 x 5/16 Pan	J5072970105	4
70	Washer No 4 STL Lock	J047940	4
75	Washer - No 4 Flat SS	J4751200106	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Yellow	M26300301	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
120	Support, Chain Hose	408-0735-00	1
125	Valve - Quick Exhaust	J3373850002	1
130	Hose, 27” LG With 1/4 M Swivel	J0327600026	1
135	Washer - 5/8” Pln Flat SST	J4751200118	1
140	Enam, #1201 Red Glypt	A040171	.01
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	7
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1
305	Washer	M334674	4
310	Cotter, 3/32 x 3/4 SST KKT	J048689	1
315	Foam Cushion	M24606303	1

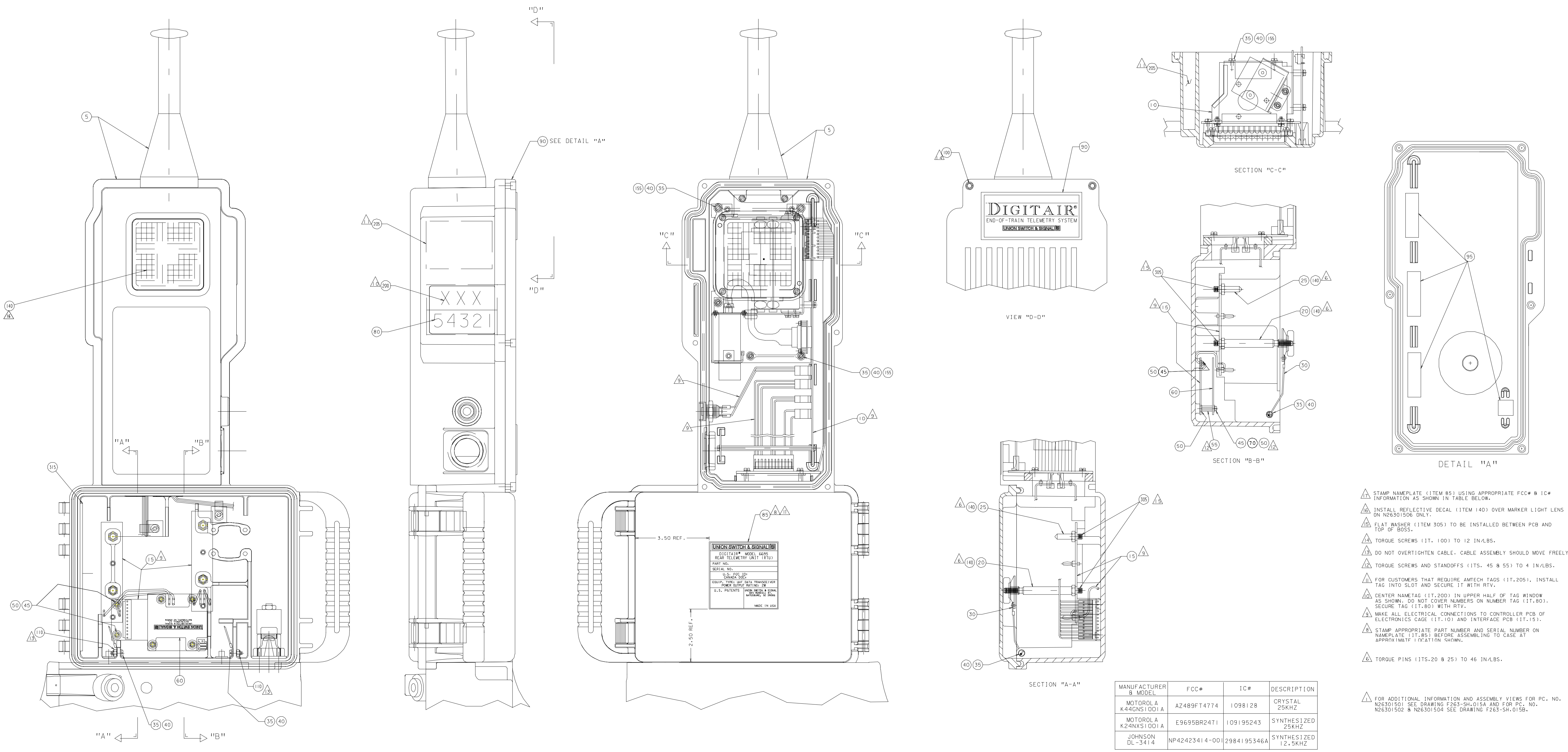
A.4 COMPOSITE SBU (NICAD BATTERY) - BLUE/YELLOW, IN-LINE VALVE, (PN: N26301504)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Blue/Yellow	N26301403	1
10	Electronics Cage Assy	N24600204	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Blue	M26300304	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
135	Washer - 5/8" Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
155	Washer, SST Lock No 6	J4751210107	7
160	Cable - Gal Steel 26" Long	J0702050630	1
165	Valve, In-Line Quick Exhaust	J7924260017	1
170	Nipple - 1/4 NPT SS	J7924260015	1
175	Air Hose Assy	J0327600050	1
200	Name Tag, CSX	M24603417	1
305	Washer	M334674	4
310	Cotter, 3/32 x 3/4 SST KKT	J048689	1
315	Foam Cushion	M24606303	1

A.5 COMPOSITE SBU (NICAD BATTERY) - ORANGE, SMALL HOSE/QUICK EXHAUST, (PN: N26301505)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Orange	N26301405	1
10	Electronics Cage Assy	N24600208	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Orange	M26300305	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
120	Support, Chain Hose	408-0735-00	1
125	Valve - Quick Exhaust	J3373850002	1
130	Hose, 27" LG With 1/4 M Swivel	J0327600026	1
135	Washer - 5/8" Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	7
200	Name Tag, CP	M24603416	1
205	Tag, Batt Shadow	J0759750031	1
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1
305	Washer, - No 10 SS 0.250" ID	J4751200126	4
310	Cotter, 3/32 x 3/4 SST KKT	J048689	1
315	Foam Cushion	M24606303	1

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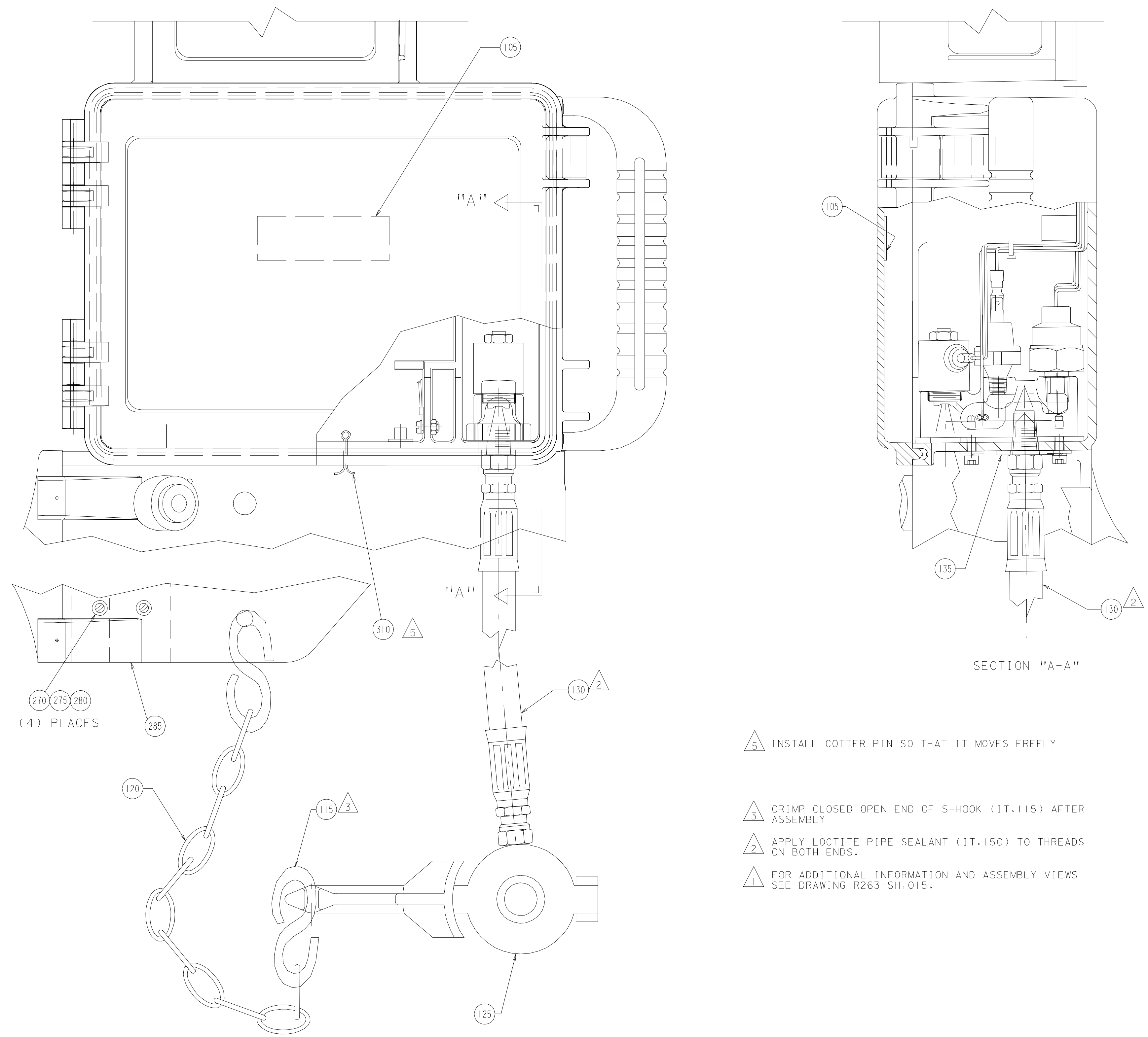


17. STAMP NAMEPLATE (ITEM 85) USING APPROPRIATE FCC# & IC# INFORMATION AS SHOWN IN TABLE BELOW.
16. INSTALL REFLECTIVE DECAL (ITEM 140) OVER MARKER LIGHT LENS ON N26301506 ONLY.
15. FLAT WASHER (ITEM 305) TO BE INSTALLED BETWEEN PCB AND TOP OF BOSS.
14. TORQUE SCREWS (IT. 100) TO 12 IN/LBS.
13. DO NOT OVERTIGHTEN CABLE. CABLE ASSEMBLY SHOULD MOVE FREELY.
12. TORQUE SCREWS AND STANDOFFS (ITS. 45 & 55) TO 4 IN/LBS.
11. FOR CUSTOMERS THAT REQUIRE AMTECH TAGS (IT.205), INSTALL TAG INTO SLOT AND SECURE IT WITH RTV.
10. CENTER NAMETAG (IT.200) IN UPPER HALF OF TAG WINDOW AS SHOWN. DO NOT COVER NUMBERS ON NUMBER TAG (IT.80). SECURE TAG (IT.80) WITH RTV.
9. MAKE ALL ELECTRICAL CONNECTIONS TO CONTROLLER PCB OF ELECTRONICS CAGE (IT.10) AND INTERFACE PCB (IT.15).
8. STAMP APPROPRIATE PART NUMBER AND SERIAL NUMBER ON NAMEPLATE (IT.85) BEFORE ASSEMBLING TO CASE AT APPROXIMATE LOCATION SHOWN.
6. TORQUE PINS (ITS.20 & 25) TO 46 IN/LBS.
1. FOR ADDITIONAL INFORMATION AND ASSEMBLY VIEWS FOR PC. NO. N26301501 SEE DRAWING F263-SH.015A AND FOR PC. NO. N26301502 & N26301504 SEE DRAWING F263-SH.015B.

MANUFACTURER & MODEL	FCC#	IC#	DESCRIPTION
MOTOROLA K44GNS1001A	AZ489FT4774	1098128	CRYSTAL 25KHZ
MOTOROLA K24NXS1001A	E9695BR2471	109195243	SYNTHESIZED 25KHZ
JOHNSON DL-3414	NP42423414-001	2984195346A	SYNTHESIZED 12.5KHZ

DWG NO: R263015

Figure A-1 - Composite SBU (NiCAD Battery) - Gray, Small Hose, Quick Exhaust Valve (PN: N26301501), Composite SBU (NiCAD Battery) - Gray, In-Line Exhaust Valve (PN: N26301502) Composite SBU (NiCAD Battery) - Yellow, Small Hose/Quick Exhaust, (PN: N26301503), Composite SBU (NiCAD Battery) - Blue/Yellow, In-Line Valve, (PN: N26301504) Composite SBU (NiCAD Battery) - Orange, Small Hose/Quick Exhaust, (PN: N26301505)



DWG NO: F263015A

Figure A-1 (Continued) - Composite SBU (NiCAD Battery) PNs: N26301501, N26301502, N26301503, N26301504, N26301505

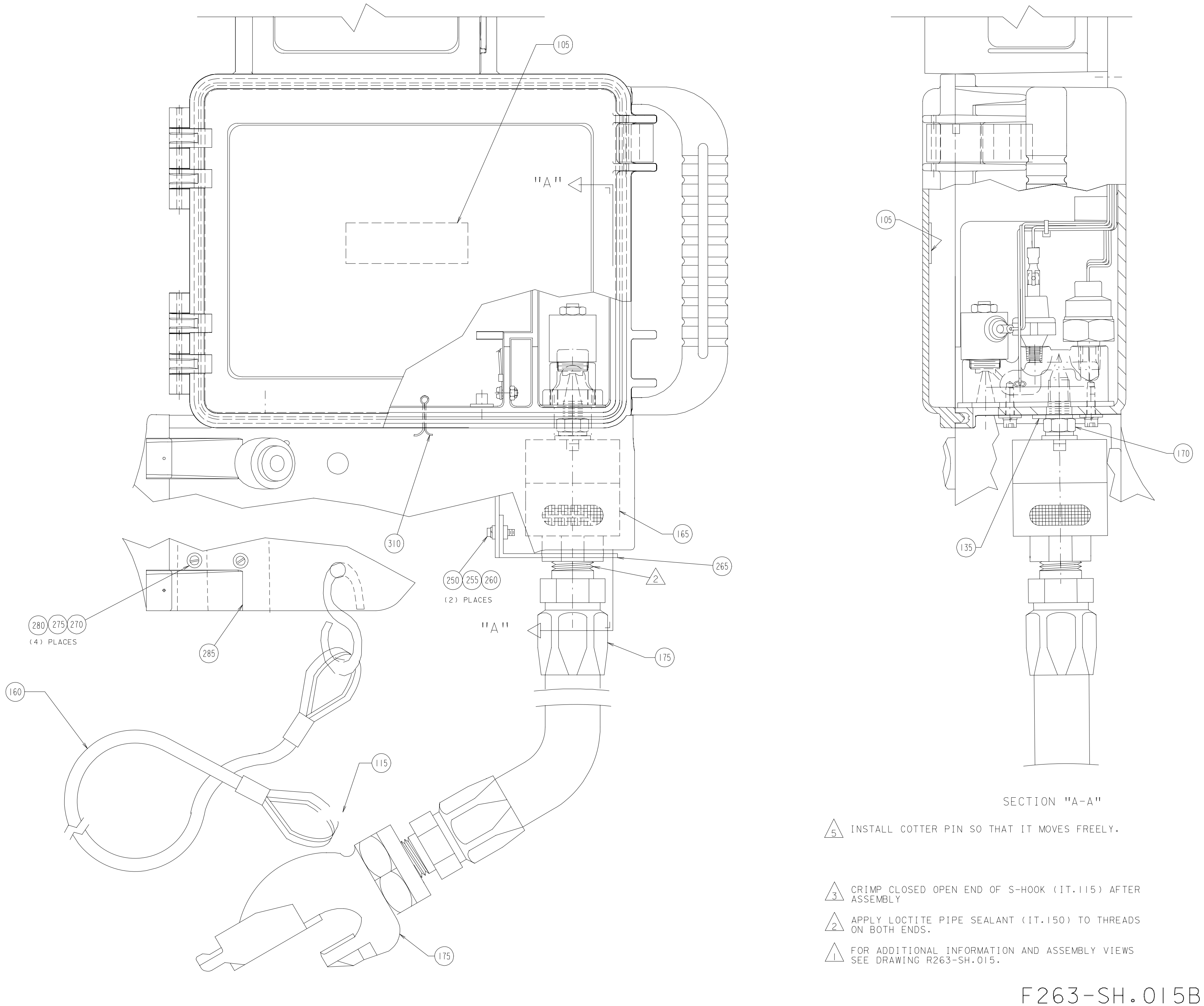


Figure A-1 (Continued) - Composite SBU (NiCAD Battery) PNs: N26301501, N26301502, N26301503, N26301504, N26301505

A.6 COMPOSITE SBU (LEAD ACID BATTERY) - GRAY, SMALL HOSE/QUICK EXHAUST, (PN: N26301601)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Gray	N26301402	1
10	Electronics Cage Assy	N24600205	1
15	PCB, NS Interface	N4519233402	1
20	Screw - Nylon 012528H037	J5072770005	4
25	Washer-Nylon 17W05009	J4751820020	4
30	Brkt, Pulse Battery	M26301101	1
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	7
40	Washer - SST Plate No 6	J4751200108	11
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Gray	M26300302	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Connector Cable Assy	N24609801	1
115	S-Hook, 2.875, Galv	408-0737-00	1
120	Support, Chain Hose	408-0735-00	1
125	Valve - Quick Exhaust	J3373850002	1
130	Hose, 27" LG with 1/4 M Swivel	J0327600026	1
135	Washer - 5/8" Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	11
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1

A.7 COMPOSITE SBU (LEAD ACID BATTERY) - YELLOW, RESETTABLE IN-LINE VALVE, (PN: N26301602)

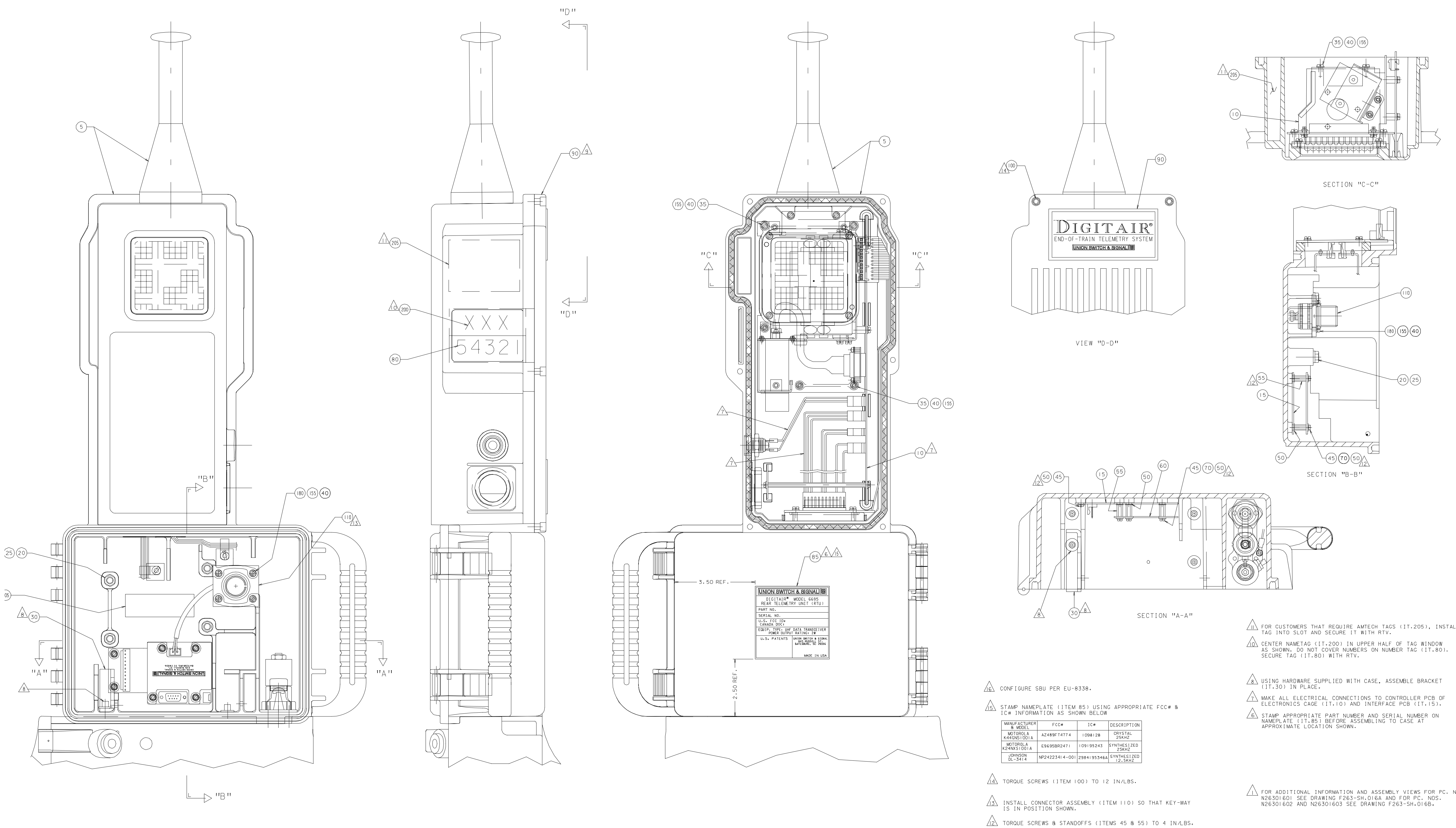
Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Yellow	N26301401	1
10	Electronics Cage Assy	N24600205	1
15	PCB, NS Interface	N4519233402	1
20	Screw - Nylon 012528H037	J5072770005	4
25	Washer-Nylon 17W05009	J4751820020	4
30	Brkt, Pulse Battery	M26301101	1
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	7
40	Washer - SST Plate No 6	J4751200108	11
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Yellow	M26300301	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Connector Cable Assy	N24609801	1
115	S-Hook, 2.875, Galv	408-0737-00	1
135	Washer - 5/8” Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	11
160	Cable - Gal Steel 26” Long	J0702050630	1
165	Valve - In-Line Resettable Qk Ex	J7924260020	1
175	Air Hose Assy - EOT	J0327600050	1
180	Screw - SST 6-32 x 2/2 Pan	J5072980108	4
200	Nametag, UPRQ	M24603445	1
205	Tag, Batt Shadow	J0759750031	1
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1
300	Assy, Bracket	N26302003	1
305	Bracket EOT	M26302002	1
310	Block, Machined EOT	M26302101	1
315	Screw - 1/4 x 1-1/4 Socket Head	J507349	3
320	Screw - 8-32 x 1/2 Flat SS	J5001240031	4
325	Nip - 1/4 NPT Close SS	J032843	1
330	Cotter - 3/32 x 3/4 SST KKT	J048689	1
335	Washer, SST Lock No 1/4	J4751210111	3

A.7 COMPOSITE SBU (LEAD ACID BATTERY) - YELLOW, RESETTABLE IN-LINE VALVE, (PN: N26301602) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
340	Tubing - Thermoplastic 1/4” OD	A7742140013	.3
345	Fitting - 90 Degree Elbow	J0327600076	1
350	Fitting - Flareless Tube	J0327600077	1
355	Fitting - Flareless Tube	J0327600078	1
360	Screw - 1/4-20 x 1, SKT SST	J5001010108	1
365	Washer, SST Plate No 1/4	J4751200112	1
370	Washer, SST Lock No 1/4	J4751210111	1
375	Threadlocker - 242	J041245	.01

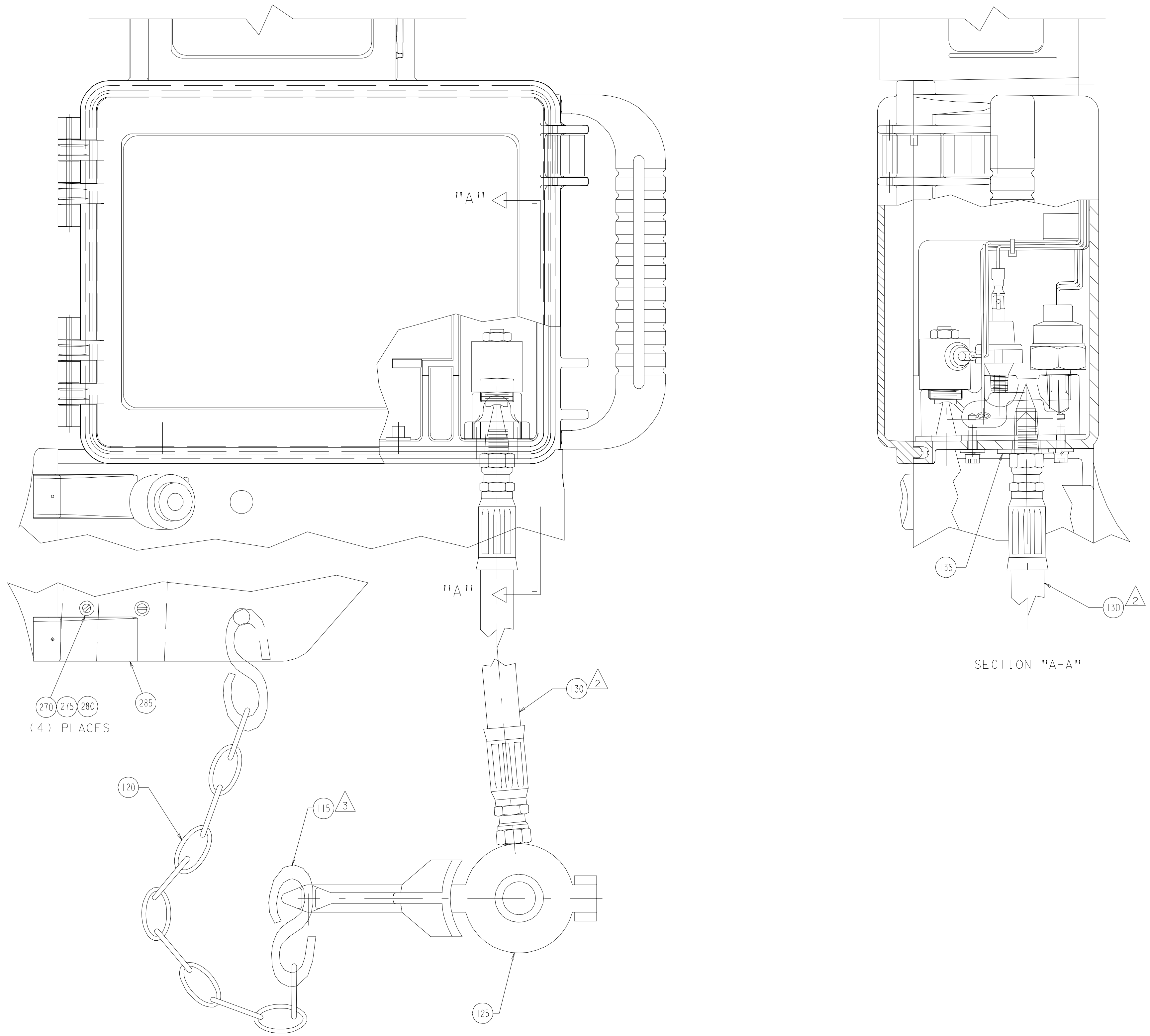
A.8 COMPOSITE SBU (LEAD ACID BATTERY) - GRAY, IN-LINE VALVE, (PN: N26301603)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Gray	N26301402	1
10	Electronics Cage Assy	N24600205	1
15	PCB, NS Interface	N4519233402	1
20	Screw - Nylon 012528H037	J5072770005	4
25	Washer-Nylon 17W05009	J4751820020	4
30	Brkt, Pulse Battery	M26301101	1
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	7
40	Washer - SST Plate No 6	J4751200108	11
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	6
50	Washer - SST .144 ID Flat	J4751210128	10
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
70	Washer No 4 STL Lock	J047940	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid, Gray	M26300302	1
95	Strip, Foam	M24603703	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Connector Cable Assy	N24609801	1
115	S-Hook, 2.875, Galv	408-0737-00	1
135	Washer - 5/8” Pln Flat SST	J4751200118	1
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	11
160	Cable - Gal Steel 26” Long	J0702050630	1
165	Valve - In-Line Quick Exhaust	J7924260017	1
170	Nipple - 1/4 NPT SS	J7924260015	1
175	Air Hose Assy - EOT	J0327600050	1
180	Screw - SST 6-32 x 1/2 Pan	J5072980108	4
205	Tag, Batt Shadow	J0759750031	1
250	Screw - 10-32 x 5/8 SOC	J5001240004	2
255	Washer, 10 Plate SST	J4751200110	2
260	Washer - SST Lock No 10	J4751210109	2
265	Bracket, Hose Support	N26301902	1
270	Screw - 8-32 x 5/8 Pan Head	J5072950110	4
275	Washer - SST Plate No 8	J4751200109	4
280	Washer - SST Lock No 8	J4751210108	4
285	Bracket, Clamp	N26302202	1



DWG NO: R263016

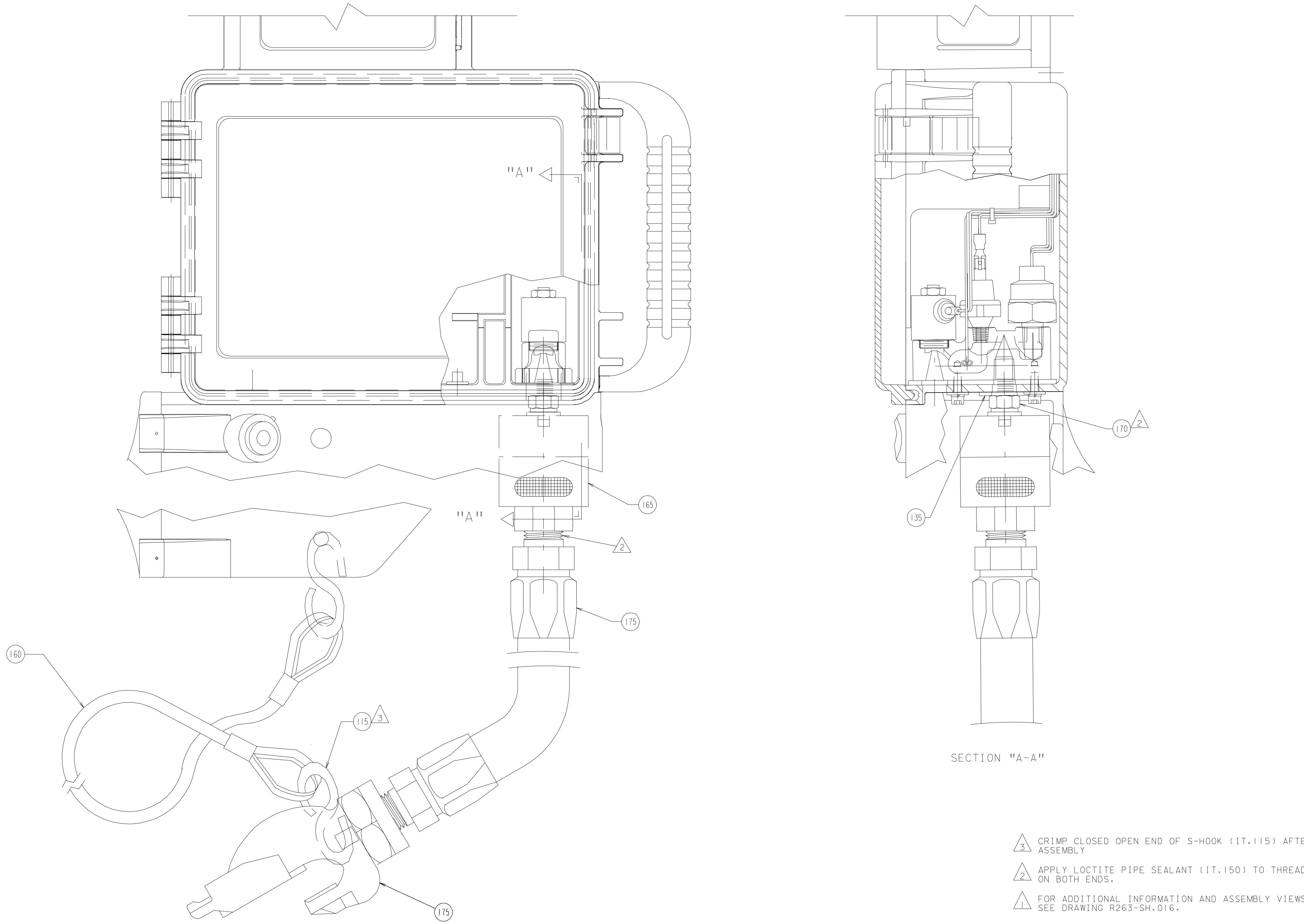
Figure A-2 Composite SBU (Lead Acid Battery) - Gray, Small Hose/Quick Exhaust, (PN: N26301601)
Composite SBU (Lead Acid Battery) - Yellow, Resettable In-Line Valve, (PN: N26301602)
Composite SBU (Lead Acid Battery) - Gray, In-Line Valve, (PN: N26301603)



DWG NO: F263016A

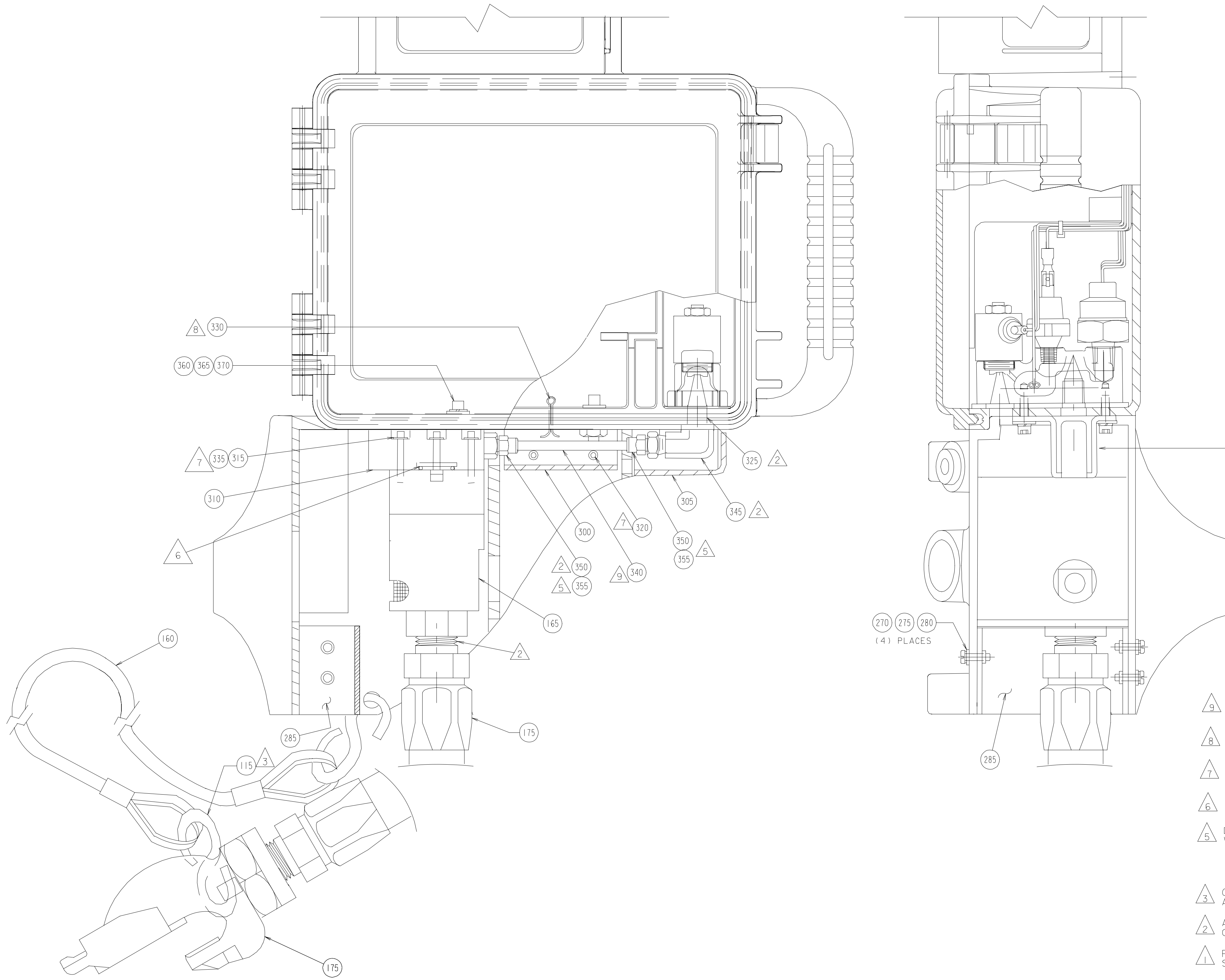
3. CRIMP CLOSED OPEN END OF S-HOOK (IT.115) AFTER ASSEMBLY
2. APPLY LOCTITE PIPE SEALANT (IT.150) TO THREADS ON BOTH ENDS.
1. FOR ADDITIONAL INFORMATION AND ASSEMBLY VIEWS SEE DRAWING R263-SH.016.

Figure A-2 (Continued) - Composite SBU (Lead Acid Battery) PNs: N26301601, N26301602, N26301603



DWG NO. F263016B

Figure A-2 (Continued) - Composite SBU (Lead Acid Battery) PNs: N26301601, N26301602, N26301603



9 WITH NUT (ITEM 355) REMOVED. MEASURE THE DISTANCE BETWEEN THE SHOULDERS OF THE TWO FITTINGS (ITEM 350). ADD 1/4" TO THE MEASURMENT. THIS IS THE LENGTH TO CUT THE TUBE (ITEM 340)

8 INSTALL COTTER PIN (ITEM 330) SO THAT IT MOVES FREELY

7 APPLY LOCTITE 242 (ITEM 375) TO THREADS

6 INSTALL O-RING SUPPLIED WITH VALVE (ITEM 165) INTO CUT-OUT IN MANIFOLD (ITEM 310)

5 DISCARD NUT SUPPLIED WITH ITEM 350 AND REPLACE WITH NUT ITEM 355

3 CRIMP CLOSED OPEN END OF S-HOOK (IT.115) AFTER ASSEMBLY

2 APPLY LOCTITE PIPE SEALANT (IT.150) TO THREADS ON BOTH ENDS.

1 FOR ADDITIONAL INFORMATION AND ASSEMBLY VIEWS SEE DRAWING R263-SH.016.

DWG NO. F263016C

Figure A-2 (Continued) - Composite SBU (Lead Acid Battery) PNs: N26301601, N26301602, N26301603

A.9 COMPOSITE SBU (NICAD BATTERY) - GRAY, DUAL PRESSURE, QUICK EXHAUST/SMALL HOSE, (PN: N26301801)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing Assy, Gray	N26301402	1
10	Electronics Cage Assy	N24600204	1
15	Assy, Battery/Interface EOT	N26301301	1
20	Pin, Battery Holding	442-0075-01	2
25	Battery Locating Pin 6621	442-0074-01	2
30	Nut, Assembly Digitair Stu	148-0176-00	2
35	Screw - 6-32 x 7/16 Pan Head	J5072980107	9
40	Washer - SST Plate No 6	J4751200108	9
45	Screw, 4-40 x 1/4 Pan SS	J5072970104	2
50	Washer - SST .144 ID Flat	J4751210128	6
55	Standoff - 4-40 x 1/2 M/F	J7259200069	4
60	Cover, Fuse	M24604601	1
65	Screw - SST 4-40 x 5/16 Pan	J5072970105	4
70	Washer No 4 STL Lock	J047940	4
75	Washer - No 4 Flat SS	J4751200106	4
80	Number Tag	M24601601	1
85	EOT Nameplate	M24603901	1
90	Rear Lid Assy (DM & IR)	M26301701	1
100	Screw - 10-32 x 5/8 SOC	J5001240004	6
105	Label, SBU	M24604801	1
110	Nut - 6-32 SS Elastic	J048102	2
115	S-Hook, 2.875, Galv	408-0737-00	1
120	Support, Chain Hose	408-0735-00	1
125	Valve - Quick Exhaust	J3373850002	1
130	Hose, 48" LG With 1/4" Npt Male	J0327600042	1
135	Washer - 5/8" Pln Flat SST	J4751200118	1
140	Enam, No 1201 Red Glypt	A040171	.01
145	Grease, Lubriplate Mag-1	438-0003-00	.1
150	Sealant, Pipe, FST	J041753	.1
155	Washer, SST Lock No 6	J4751210107	7
205	Tag, Batt Shadow	J0759750031	1

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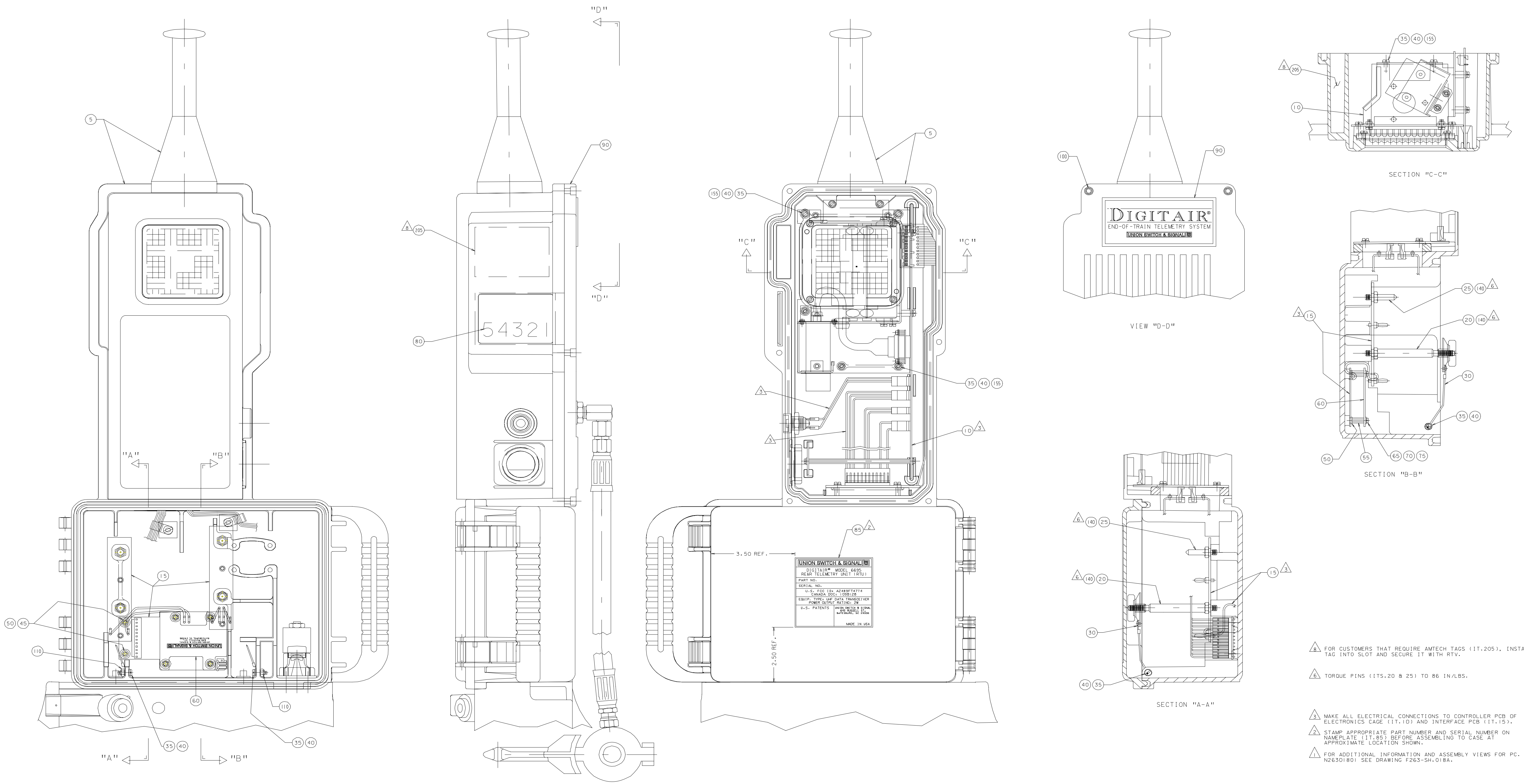
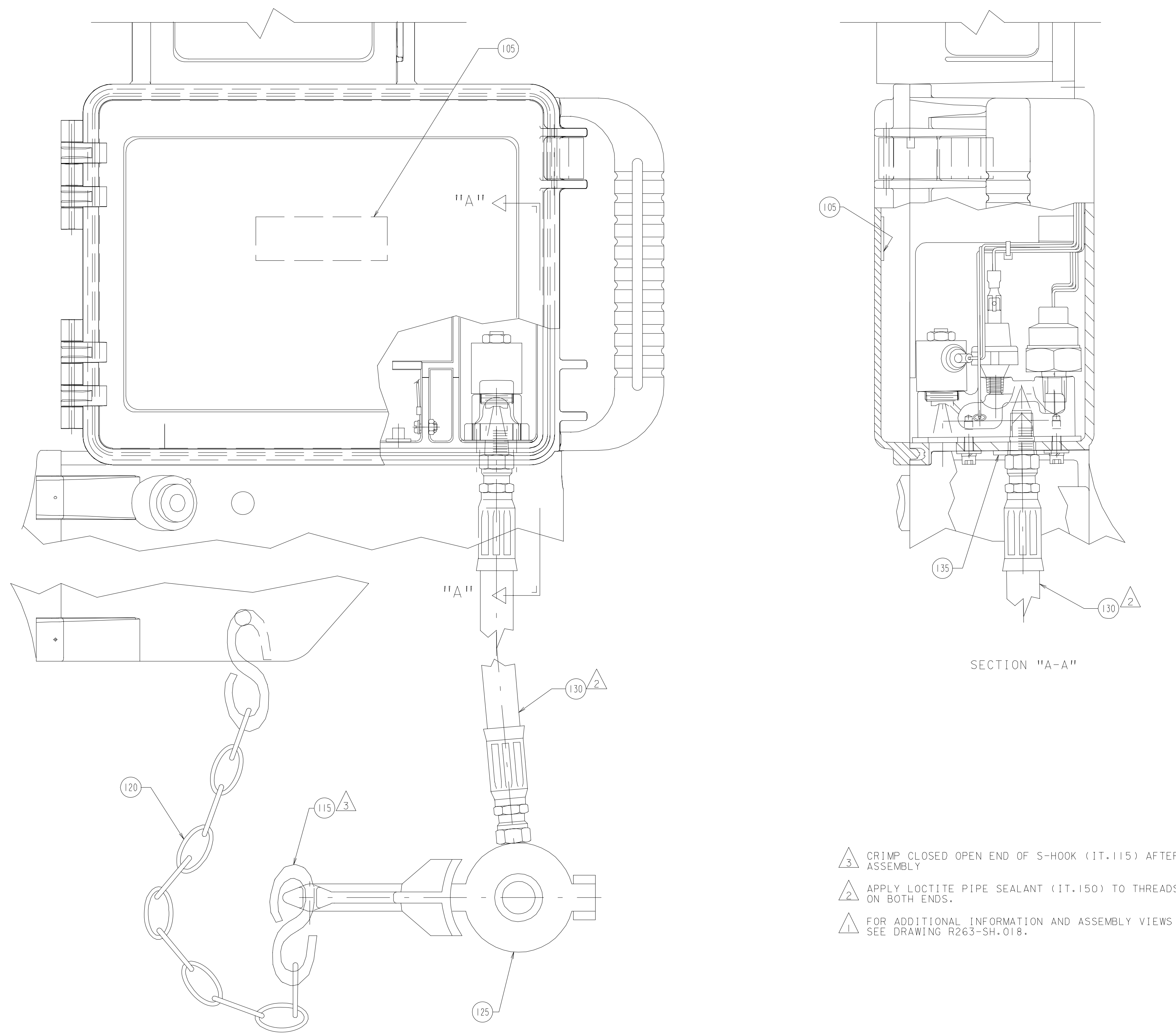


Figure A-3 - Composite SBU (NiCAD Battery) - Gray, Dual Pressure, Quick Exhaust/Small Hose, (PN: N26301801)

DWG NO: R263018



DWG NO: R263018A

Figure A-3 (Continued) - Composite SBU (NiCAD Battery) PN: N26301801

A.10 MAIN HOUSING ASSEMBLY, YELLOW (PN: N26301401)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, With Door Yellow	N26301201	1
10	Antenna - Cone Shaped	J7930730013	1
15	Lens, Marker	M24601101	1
20	Lens, Marker Gasket	M24601102	1
30	Pin - Dowel 3/16 x 1-1/4 SS	J0487220005	2
35	EOT, Adapter Assy	N24609901	1
40	Washer - SST Plate No 6	J4751200108	8
45	Washer - SST Lock No 6	J4751210107	8
50	Display, Lens	M24601301	1
55	O-Ring AS-568A No 130	J0675840004	1
60	Nut, 1-1/2-12 Retaining	M24601302	1
65	Switch - Push Button SPST	J7257070500	1
70	Test Switch Cable Assy	N24602101	1
75	Cast Manifold Assy	N24604101	1
80	Screw - 10-32 x 5/8 SOC	J5001240004	4
85	Gasket, Manifold	M24604303	1
90	Screw - SST 6-32 x 1/2 Pan	J5072980108	8
95	Decal - Tape, Reflective Bat Dor	M24600805	1
100	Decal - Tape, Reflective Enclosur	M24600804	1
105	Assy, Cable EOT Manifold	N26300901	1
110	Assy, Cable EOT	N26301001	1
115	Washer, 10 Plate SST	J4751200110	4
120	Tape - Acrylic Foam 2” W	J0773730024	.006
130	Washer - SST Lock No 10	J4751210109	6
135	Adhesive - Loctite 454	J0416080005	.1
140	Grease Lubriplate Mag-1	438-0003-00	.1
145	Jaw, Moveable	M24602601	1
150	Jaw Fixed Stu Mount (Raw)	442-0050-00	1
155	Crank Handle Assy	N24607401	1
160	Wedged Foot Digitair Stu	440-0039-00	2
165	Washer, Flat, 1/2”, 1.250 O.D.	390-0214-00	2
170	Screw, Self Tap, No 6, 0.750	376-1523-00	2
175	Ring, C Size 125 External	408-0423-00	1
180	Button, Plug 5/8 Black	441-0064-00	1
185	Retainer, Shaft	M24603001	1
190	Screw - 8-32 x 1/2 Hex Skt HdSS	J5001240032	4
195	Latch	M24607101	1
200	Pin, 1-1/4 Lr-Elas-Stp	J048714	1
205	Spring, Latch Assy	M24607501	1
210	Washer - 3/8” Flat SS	00305102	2
215	Screw - SST 3/8-16 x 3”	J5073490148	1
220	Nut - 3/8-16 Elas Stop	J480011	1
225	Bushing	M24607601	1

A.10 MAIN HOUSING ASSEMBLY, YELLOW (PN: N26301401) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
230	Plunger - 1/2-13 Thread	J0770460008	1
235	Nut - 1/2-13 Hvy Jm SS	J4803170110	2
245	Lubricant, 14 oz Cartridge	438-0002-00	.01
250	S-Hook, 2.875, Galv	408-0737-00	2
255	Clamp - Cable HP-6NG1	J6902340022	2
260	Screw - 10-32 x 1/2 Pan SS	J5072960108	2
270	O-Ring EOT Conductive 36”	J0675840012	1
275	O-Ring EOT Conductive 39.75”	J0675840011	1
280	Bracket, EOT Clamp Retainer	M26302401	1
300	Gasket, RF	M24610201	1
310	SBU Antenna Gasket	M24306101	1

A.11 MAIN HOUSING ASSEMBLY, GRAY (PN: N26301402)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, With Door Gray	N26301202	1
10	Antenna - Cone Shaped	J7930730013	1
15	Lens, Marker	M24601101	1
20	Lens, Marker Gasket	M24601102	1
30	Pin - Dowel 3/16 x 1-1/4 SS	J0487220005	2
35	EOT, Adapter Assy	N24609901	1
40	Washer - SST Plate No 6	J4751200108	8
45	Washer - SST Lock No 6	J4751210107	8
50	Display, Lens	M24601301	1
55	O-Ring AS-568A No 130	J0675840004	1
60	Nut, 1-1/2-12 Retaining	M24601302	1
65	Switch - Push Button SPST	J7257070500	1
70	Test Switch Cable Assy	N24602101	1
75	Cast Manifold Assy	N24604101	1
80	Screw - 10-32 x 5/8 SOC	J5001240004	4
85	Gasket, Manifold	M24604303	1
90	Screw - SST 6-32 x 1/2 Pan	J5072980108	8
95	Decal - Tape, Reflective Bat Dor	M24600805	1
100	Decal - Tape, Reflective Enclosure	M24600804	1
105	Assy, Cable EOT Manifold	N26300901	1
110	Assy, Cable EOT	N26301001	1
115	Washer, 10 Plate SST	J4751200110	4
120	Tape - Acrylic Foam 2” W	J0773730024	.006
130	Washer - SST Lock No 10	J4751210109	6
135	Adhesive - Loctite 454	J0416080005	.1
140	Grease Lubriplate Mag-1	438-0003-00	.1
145	Jaw, Moveable	M24602601	1
150	Jaw Fixed Stu Mount (Raw)	442-0050-00	1
155	Crank Handle Assy	N24607401	1
160	Wedged Foot Digitair Stu	440-0039-00	2
165	Washer, Flat, 1/2”, 1.250 O.D.	390-0214-00	2
170	Screw, Self Tap, No 6, 0.750	376-1523-00	2
175	Ring, C Size 125 External	408-0423-00	1
180	Button, Plug 5/8 Black	441-0064-00	1
185	Retainer, Shaft	M24603001	1
190	Screw - 8-32 x 1/2 Hex Skt HdSS	J5001240032	4
195	Latch	M24607101	1
200	Pin, 1-1/4 Lr-Elas-Stp	J048714	1
205	Spring, Latch Assy	M24607501	1
210	Washer - 3/8” Flat SS	00305102	2
215	Screw - SST 3/8-16 x 3”	J5073490148	1
220	Nut - 3/8-16 Elas Stop	J480011	1
225	Bushing	M24607601	1
230	Plunger - 1/2-13 Thread	J0770460008	1

A.11 MAIN HOUSING ASSEMBLY, GRAY (PN: N26301402) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
235	Nut - 1/2-13 Hvy Jm SS	J4803170110	2
245	Lubricant, 14 oz Cartridge	438-0002-00	.01
250	S-Hook, 2.875, Galv	408-0737-00	2
255	Clamp - Cable HP-6NG1	J6902340022	2
260	Screw - 10-32 x 1/2 Pan SS	J5072960108	2
270	O-Ring EOT Conductive 36”	J0675840012	1
275	O-Ring EOT Conductive 39.75”	J0675840011	1
280	Bracket, EOT Clamp Retainer	M26302401	1
300	Gasket, RF	M24610201	1
310	SBU Antenna Gasket	M24306101	1

A.12 MAIN HOUSING ASSEMBLY, BLUE/YELLOW (PN: N26301403)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, With Door Blu/Yel	N26301201	1
10	Antenna - Cone Shaped	J7930730013	1
15	Lens, Marker	M24601101	1
20	Lens, Marker Gasket	M24601102	1
30	Pin - Dowel 3/16 x 1-1/4 SS	J0487220005	2
35	EOT, Adapter Assy	N24609901	1
40	Washer - SST Plate No 6	J4751200108	8
45	Washer - SST Lock No 6	J4751210107	8
50	Display, Lens	M24601301	1
55	O-Ring AS-568A No 130	J0675840004	1
60	Nut, 1-1/2-12 Retaining	M24601302	1
65	Switch - Push Button SPST	J7257070500	1
70	Test Switch Cable Assy	N24602101	1
75	Cast Manifold Assy	N24604101	1
80	Screw - 10-32 x 5/8 SOC	J5001240004	4
85	Gasket, Manifold	M24604303	1
90	Screw - SST 6-32 x 1/2 Pan	J5072980108	8
95	Decal - Tape, Reflective Bat Dor	M24600805	1
100	Decal - Tape, Reflective Enclosur	M24600804	1
105	Assy, Cable EOT Manifold	N26300901	1
110	Assy, Cable EOT	N26301001	1
115	Washer, 10 Plate SST	J4751200110	4
120	Tape - Acrylic Foam 2" W	J0773730024	.006
130	Washer - SST Lock No 10	J4751210109	6
135	Adhesive - Loctite 454	J0416080005	.1
140	Grease Lubriplate Mag-1	438-0003-00	.1
145	Jaw, Moveable	M24602601	1
150	Jaw Fixed Stu Mount (Raw)	442-0050-00	1
155	Crank Handle Assy	N24607401	1
160	Wedged Foot Digitair Stu	440-0039-00	2
165	Washer, Flat, 1/2", 1.250 O.D.	390-0214-00	2
170	Screw, Self Tap, No 6, 0.750	376-1523-00	2
175	Ring, C Size 125 External	408-0423-00	1
180	Button, Plug 5/8 Black	441-0064-00	1
185	Retainer, Shaft	M24603001	1
190	Screw - 8-32 x 1/2 Hex Skt HdSS	J5001240032	4
195	Latch	M24607101	1
200	Pin, 1-1/4 Lr-Elas-Stp	J048714	1
205	Spring, Latch Assy	M24607501	1
210	Washer - 3/8" Flat SS	00305102	2
215	Screw - SST 3/8-16 x 3"	J5073490148	1
220	Nut - 3/8-16 Elas Stop	J480011	1

A.12 MAIN HOUSING ASSEMBLY, BLUE/YELLOW (PN: N26301403) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
225	Bushing	M24607601	1
230	Plunger - 1/2-13 Thread	J0770460008	1
235	Nut - 1/2-13 Hvy Jm SS	J4803170110	2
245	Lubricant, 14 oz Cartridge	438-0002-00	.01
250	S-Hook, 2.875, Galv	408-0737-00	2
255	Clamp - Cable HP-6NG1	J6902340022	2
260	Screw - 10-32 x 1/2 Pan SS	J5072960108	2
270	O-Ring EOT Conductive 36”	J0675840012	1
275	O-Ring EOT Conductive 39.75”	J0675840011	1
280	Bracket, EOT Clamp Retainer	M26302401	1
300	Gasket, RF	M24610201	1
310	SBU Antenna Gasket	M24306101	1

A.13 MAIN HOUSING (PN: N26301404)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing	N26301204	1
10	Antenna - Cone Shaped	J7930730013	1
15	Lens, Marker	M24601101	1
20	Lens, Marker Gasket	M24601102	1
30	Pin - Dowel 3/16 x 1-1/4 SS	J0487220005	2
35	EOT, Adapter Assy	N24609901	1
40	Washer - SST Plate No 6	J4751200108	8
45	Washer - SST Lock No 6	J4751210107	8
50	Display, Lens	M24601301	1
55	O-Ring AS-568A No 130	J0675840004	1
60	Nut, 1-1/2-12 Retaining	M24601302	1
65	Switch - Push Button SPST	J7257070500	1
70	Test Switch Cable Assy	N24602101	1
75	Cast Manifold Assy	N24604101	1
80	Screw - 10-32 x 5/8 SOC	J5001240004	4
85	Gasket, Manifold	M24604303	1
90	Screw - SST 6-32 x 1/2 Pan	J5072980108	8
95	Decal - White	M24600807	1
100	Decal - White	M24600806	1
105	Assy, Cable EOT Manifold	N26300901	1
110	Assy, Cable EOT	N26301001	1
115	Washer, 10 Plate SST	J4751200110	4
120	Tape - Acrylic Foam 2" W	J0773730024	.006
130	Washer - SST Lock No 10	J4751210109	6
135	Adhesive - Loctite 454	J0416080005	.1
140	Grease Lubriplate Mag-1	438-0003-00	.1
145	Jaw, Moveable	M24602601	1
150	Jaw Fixed Stu Mount (Raw)	442-0050-00	1
155	Crank Handle Assy	N24607401	1
160	Wedged Foot Digitair Stu	440-0039-00	2
165	Washer, Flat, 1/2", 1.250 O.D.	390-0214-00	2
170	Screw, Self Tap, No 6, 0.750	376-1523-00	2
175	Ring, C Size 125 External	408-0423-00	1
180	Button, Plug 5/8 Black	441-0064-00	1
185	Retainer, Shaft	M24603001	1
190	Screw - 8-32 x 1/2 Hex Skt HdSS	J5001240032	4
195	Latch	M24607101	1
200	Pin, 1-1/4 Lr-Elas-Stp	J048714	1
205	Spring, Latch Assy	M24607501	1
210	Washer - 3/8" Flat SS	00305102	2
215	Screw - SST 3/8-16 x 3"	J5073490148	1
220	Nut - 3/8-16 Elas Stop	J480011	1

A.13 MAIN HOUSING (PN: N26301404) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
225	Bushing	M24607601	1
230	Plunger - 1/2-13 Thread	J0770460008	1
235	Nut - 1/2-13 Hvy Jm SS	J4803170110	2
245	Lubricant, 14 oz Cartridge	438-0002-00	.01
250	S-Hook, 2.875, Galv	408-0737-00	2
255	Clamp - Cable HP-6NG1	J6902340022	2
260	Screw - 10-32 x 1/2 Pan SS	J5072960108	2
270	O-Ring EOT Conductive 36”	J0675840012	1
275	O-Ring EOT Conductive 39.75”	J0675840011	1
280	Bracket, EOT Clamp Retainer	M26302401	1
300	Gasket, RF	M24610201	1
310	SBU Antenna Gasket	M24306101	1

A.14 ASSEMBLY, MAIN HOUSING (PN: N26301405)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing	N26301205	1
10	Antenna - Cone Shaped	J7930730013	1
15	Lens, Marker	M24601101	1
20	Lens, Marker Gasket	M24601102	1
30	Pin - Dowel 3/16 x 1-1/4 SS	J0487220005	2
35	EOT, Adapter Assy	N24609901	1
40	Washer - SST Plate No 6	J4751200108	8
45	Washer - SST Lock No 6	J4751210107	8
50	Display, Lens	M24601301	1
55	O-Ring AS-568A No 130	J0675840004	1
60	Nut, 1-1/2-12 Retaining	M24601302	1
65	Switch - Push Button SPST	J7257070500	1
70	Test Switch Cable Assy	N24602101	1
75	Cast Manifold Assy	N24604101	1
80	Screw - 10-32 x 5/8 SOC	J5001240004	4
85	Gasket, Manifold	M24604303	1
90	Screw - SST 6-32 x 1/2 Pan	J5072980108	8
95	Decal - Tape, Reflective Bat Dor	M24600805	1
100	Decal - Tape, Reflective Enclosur	M24600804	1
105	Assy, Cable EOT Manifold	N26300901	1
110	Assy, Cable EOT	N26301001	1
115	Washer, 10 Plate SST	J4751200110	4
120	Tape - Acrylic Foam 2” W	J0773730024	.006
130	Washer - SST Lock No 10	J4751210109	6
135	Adhesive - Loctite 454	J0416080005	.1
140	Grease Lubriplate Mag-1	438-0003-00	.1
145	Jaw, Moveable	M24602601	1
150	Jaw Fixed Stu Mount (Raw)	442-0050-00	1
155	Crank Handle Assy	N24607401	1
160	Wedged Foot Digitair Stu	440-0039-00	2
165	Washer, Flat, 1/2”, 1.250 O.D.	390-0214-00	2
170	Screw, Self Tap, No 6, 0.750	376-1523-00	2
175	Ring, C Size 125 External	408-0423-00	1
180	Button, Plug 5/8 Black	441-0064-00	1
185	Retainer, Shaft	M24603001	1
190	Screw - 8-32 x 1/2 Hex Skt HdSS	J5001240032	4
195	Latch	M24607101	1
200	Pin, 1-1/4 Lr-Elas-Stp	J048714	1
205	Spring, Latch Assy	M24607501	1
210	Washer - 3/8” Flat SS	00305102	2
215	Screw - SST 3/8-16 x 3”	J5073490148	1
220	Nut - 3/8-16 Elas Stop	J480011	1
225	Bushing	M24607601	1
230	Plunger - 1/2-13 Thread	J0770460008	1

A.14   ASSEMBLY, MAIN HOUSING (PN: N26301405) (CONTINUED)

Item No.	Description	Part Number	Quantity per Assembly
235	Nut - 1/2-13 Hvy Jm SS	J4803170110	2
245	Lubricant, 14 oz Cartridge	438-0002-00	.01
250	S-Hook, 2.875, Galv	408-0737-00	2
255	Clamp - Cable HP-6NG1	J6902340022	2
260	Screw - 10-32 x 1/2 Pan SS	J5072960108	2
270	O-Ring EOT Conductive 36”	J0675840012	1
275	O-Ring EOT Conductive 39.75”	J0675840011	1
280	Bracket, EOT Clamp Retainer	M26302401	1
300	Gasket, RF	M24610201	1
310	SBU Antenna Gasket	M24306101	1

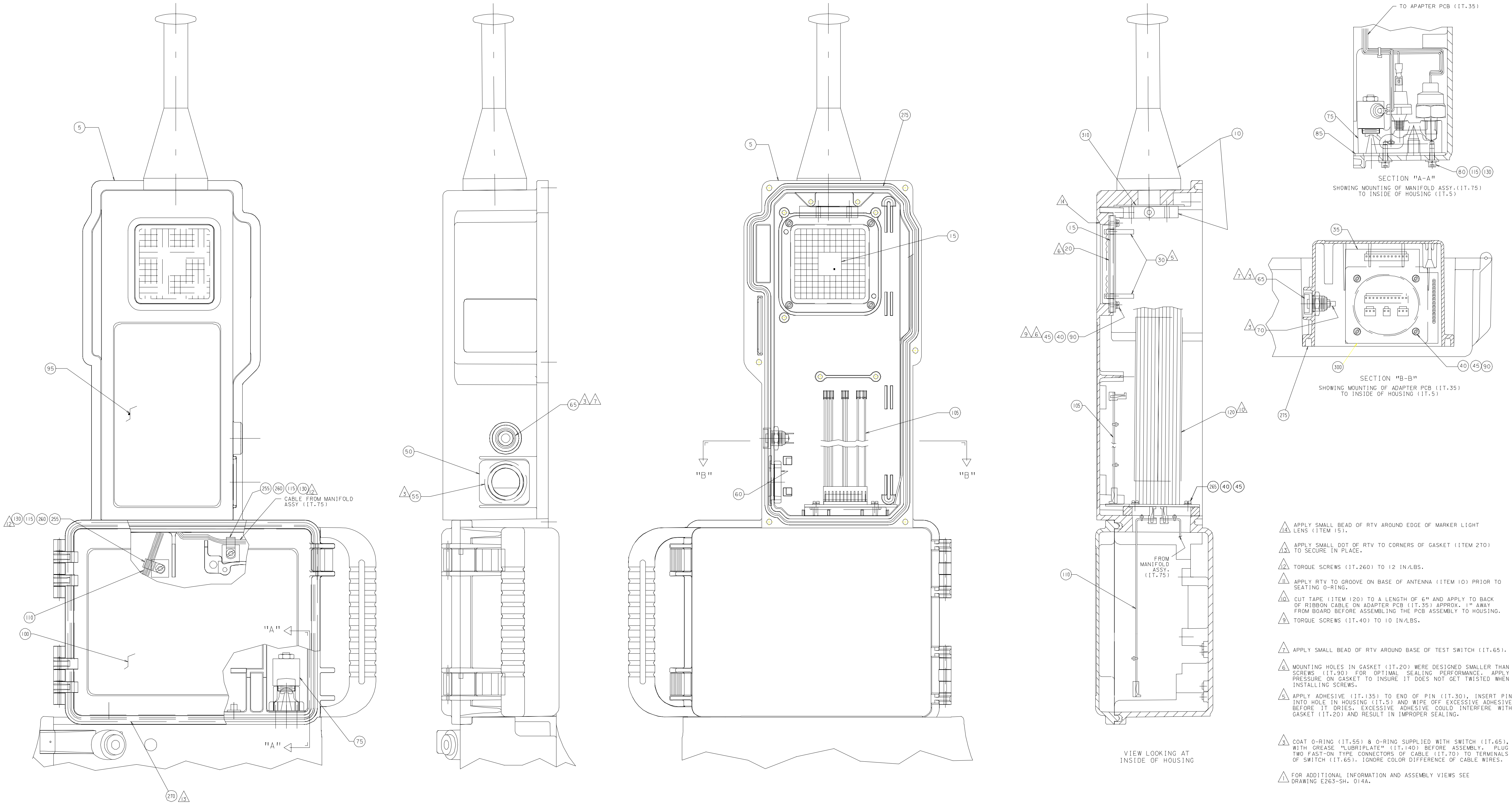
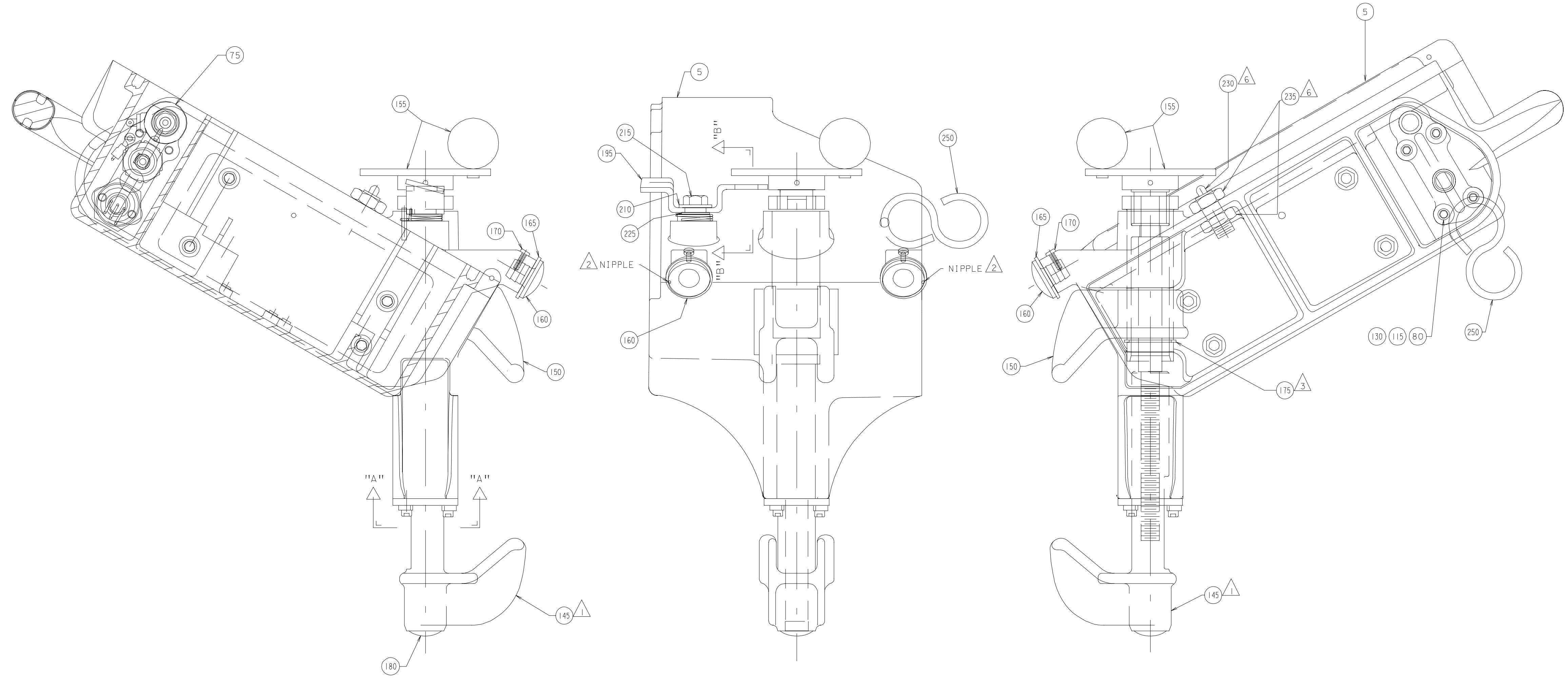
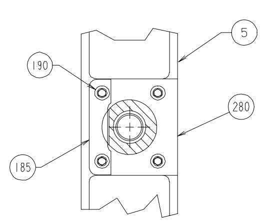


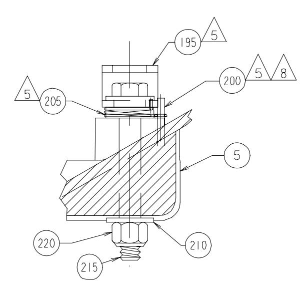
Figure - A-4 - Main Housing Assembly: Yellow - PN: N26301401
Gray - PN: N26301402
Blue/Yellow -PN: N26301403,
Main Housing - PN: N26301404,
Main Housing Assembly - PN: N26301405

DWG NO: R263014





SECTION "A-A"



SECTION "B-B"

9. THIS SHEET IS NOT REQUIRED FOR ASSY. OF N26301406.

8. APPLY A DROP OF LOCTITE 454 TO SPRING PIN (IT.200) TO HOLD IN PLACE.

6. APPLY LOCTITE 425 TO THREADS ON PLUNGER (IT.230) AND NUTS (IT.235) PRIOR TO ASSEMBLY.

5. INSTALL SPRING (IT.205) SO THAT "LOOP" END IS WRAPPED AROUND ROLL PIN (IT.200) AND END WITH 90° BEND IS INSTALLED INTO HOLE ON LATCH (IT.195).

3. WHEN CRANK HANDLE ASSEMBLY (IT.155) IS FULLY INSTALLED, SEAT RETAINING RING (IT.175) INTO GROOVE.

2. NIPPLE ON FEET (IT.160) FACES OUTWARDS WHEN INSTALLED. FEET ARE SECURED IN POSITION WITH SCREWS (IT.170) AS SHOWN.

1. LUBRICATE WITH LUBRIPLATE GREASE (IT.245).

FOR ALL ADDITIONAL NOTES, VIEWS AND PART NUMBERS SEE DWG. R263-SH.014.

Figure A-4 - Main Housing Assembly (Continued): PNs: N26301401, N26301402, N26301403, N26301404, N26301405

DWG NO: E263014A

A.15 MAIN HOUSING WITH DOOR, YELLOW (PN: N26301201)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, Yellow	N26300401	1
10	Door, Battery, Yellow	M26300101	1
15	Latch, EOT	M26302301	2
20	Pin - Hinge-SS EOT - BCHO - 16	J5611290008	2
25	Pin - Latch-SS EOT - BCLP - 15	J5611310016	2

A.16 MAIN HOUSING WITH DOOR, GRAY (PN: N26301202)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, Gray	N26300402	1
10	Door, Battery, Gray	M26300102	1
15	Latch, EOT	M26302301	2
20	Pin - Hinge-SS EOT - BCHO - 16	J5611290008	2
25	Pin - Latch-SS EOT - BCLP - 15	J5611310016	2

A.17 MAIN HOUSING WITH DOOR, BLUE/YELLOW (PN: N26301203)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, Blue/Yellow	N26300403	1
10	Door, Battery, Blue/Yellow	M26300103	1
15	Latch, EOT	M26302301	2
20	Pin - Hinge-SS EOT - BCHO - 16	J5611290008	2
25	Pin - Latch-SS EOT - BCLP - 15	J5611310016	2

A.18 MAIN HOUSING WITH DOOR (PN: N26301204)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing	N26300404	1
10	Door, Battery, Yellow	M26300101	1
15	Latch, EOT	M26302301	2
20	Pin - Hinge-SS EOT - BCHO - 16	J5611290008	2
25	Pin - Latch-SS EOT - BCLP - 15	J5611310016	2

A.19 MAIN HOUSING (PN: N26301205)

Item No.	Description	Part Number	Quantity per Assembly
5	Main Housing, Orange	N26300405	1
10	Door, Battery	M26300104	1
15	Latch, EOT	M26302301	2
20	Pin - Hinge-SS EOT - BCHO - 16	J5611290008	2
25	Pin - Latch-SS EOT - BCLP - 15	J5611310016	2

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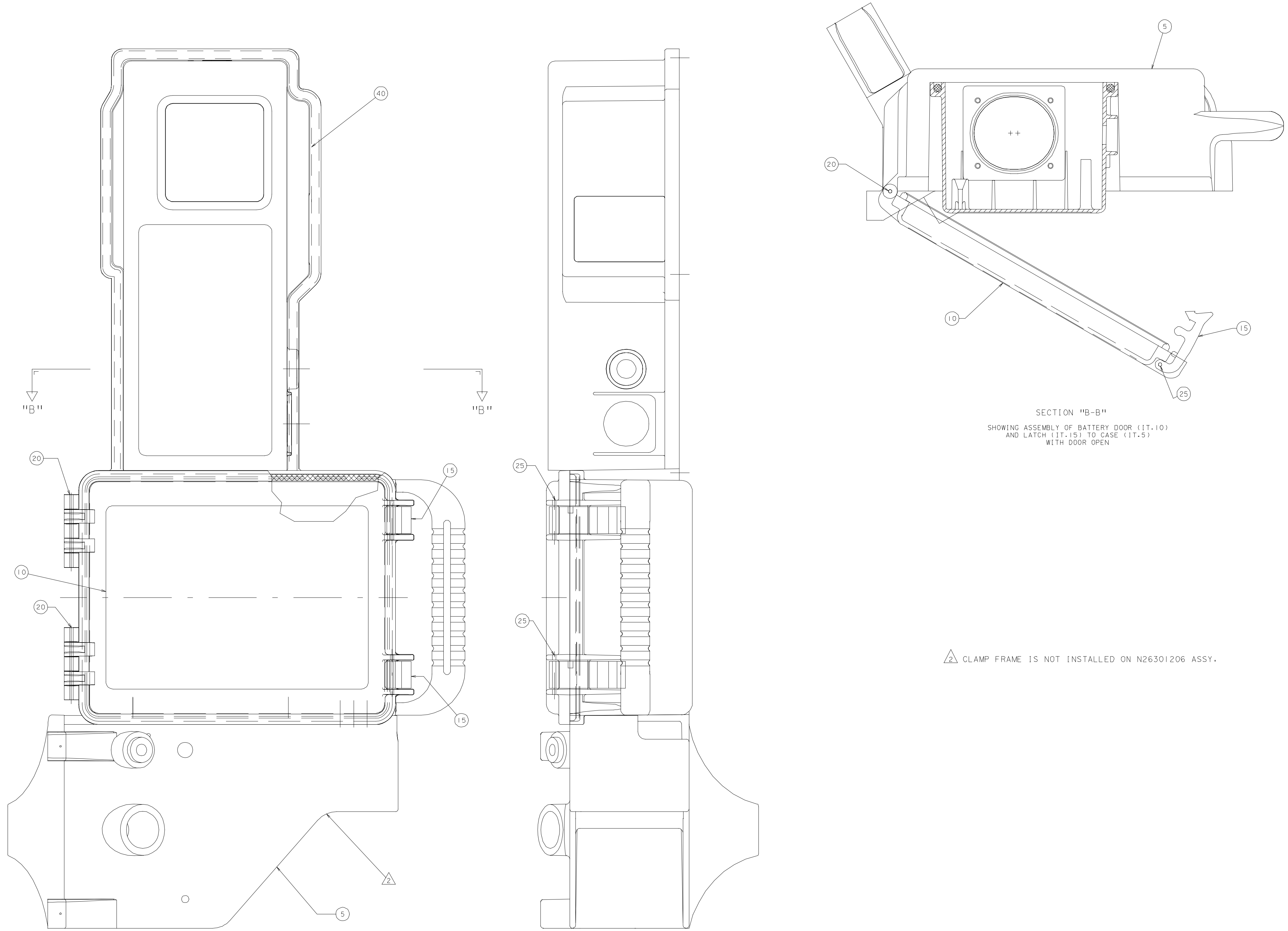
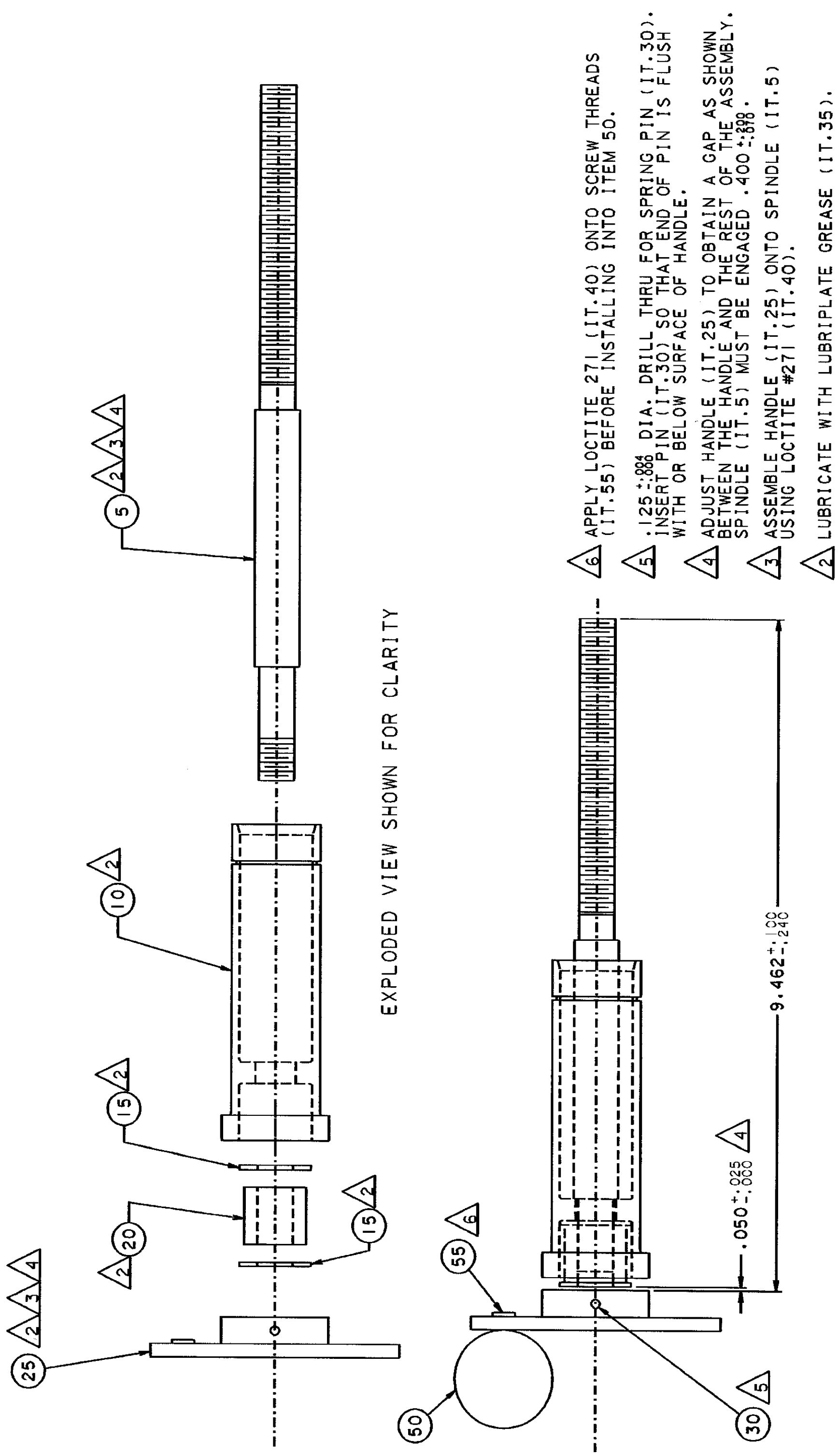


Figure A-5- Main Housing With Door, Yellow - PN: N26301201
Gray - PN: N26301202
Blue/Yellow - PN: N26301203
Main Housing with Door - PN: N26301204
Main Housing - PN: N26301205

DWG NO: R263012

A.20 CRANK HANDLE ASSEMBLY (PN: N24607401)

Item No.	Description	Part Number	Quantity per Assembly
5	Spindle, Claw	M24602501	1
10	Bushing, Coupler Mnt	M24602401	1
15	Bearing, Thrust Oilite	548-0001-00	2
20	Spring, Take Up Digitair	410-0003-00	1
25	Crank Handle	M24607001	1
30	Spring Pin, 1/80 x, *75 Long	408-0732-00	1
35	Lubricant, 14 oz Cartridge	438-0002-00	.01
40	Loctite 271 Perm Thread Locker	426-0036-00	.01
50	Knob - Black Phenolic	J0770460007	1
55	Screw - 5/16-18 x 5/8 FH SS	J5001240065	1



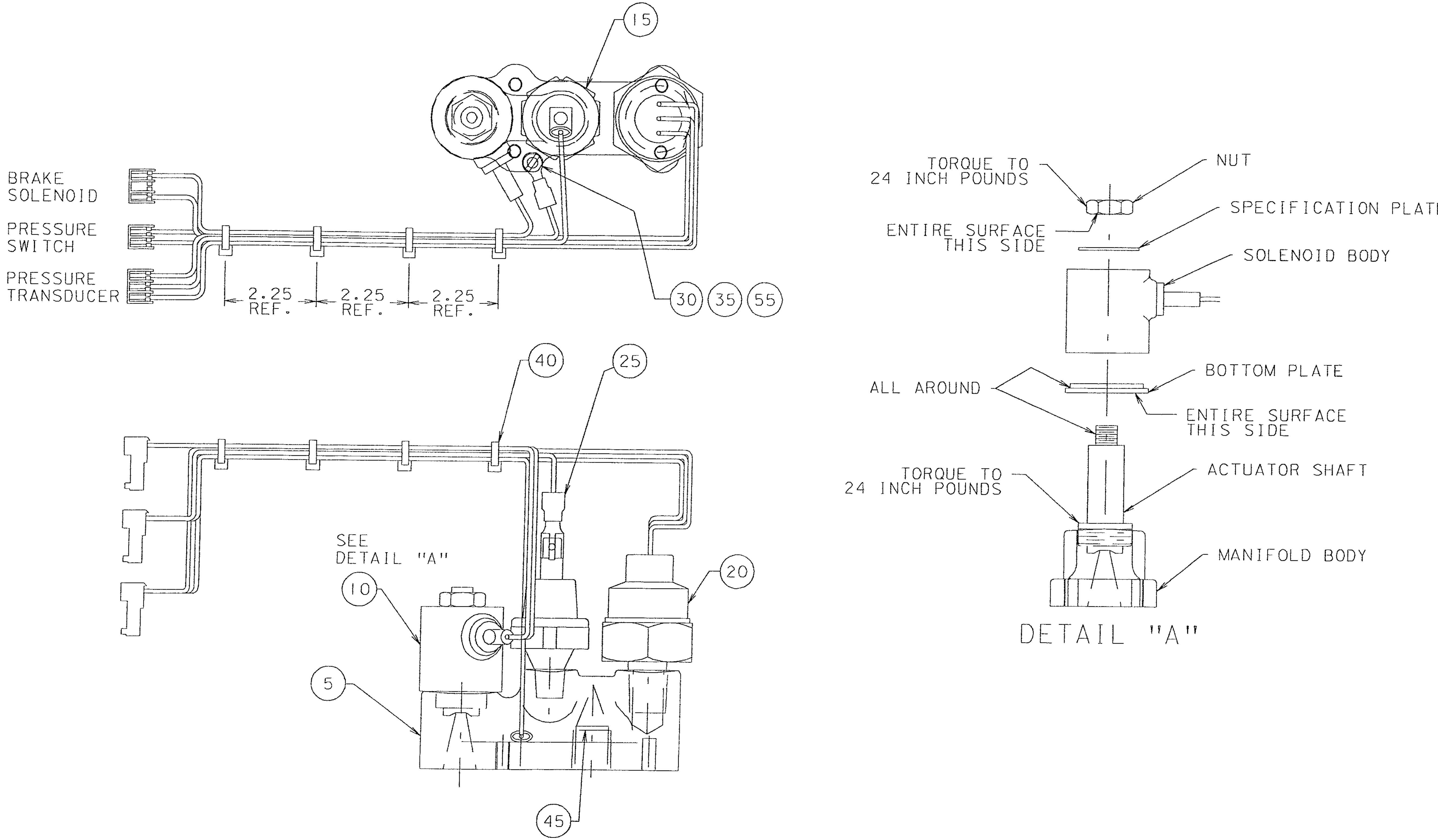
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Figure A-6 - Crank Handle Assembly - PN: N24607401

A.21 Cast Manifold Assembly (PN: N24604101)

Item No.	Description	Part Number	Quantity per Assembly
5	Manifold, Cast	M24604002	1
10	Solenoid Valve Assy	N2460119-01	1
15	Switch, Pressure Brk	468-0049-00	1
20	Pressure Transducer Assy	N246020-01	1
25	Pressure Switch Cable Assy	N246022-01	1
30	Screw - SST 6-32 x 5/16 Pan	J507298-0105	1
35	Washer - SST Plate No 6	J475120-0108	1
40	Cable, Tie Self Lkg	J703310	4
45	Screen	M24604201	1
50	Adhesive - Loctite 454	J041608-0005	.01
55	Threadlocker - 242	J041245	.1
60	Compound - RTV Adhes/Seal	J041943	.1
65	Sealant, Pipe, Fst	J041753	.1

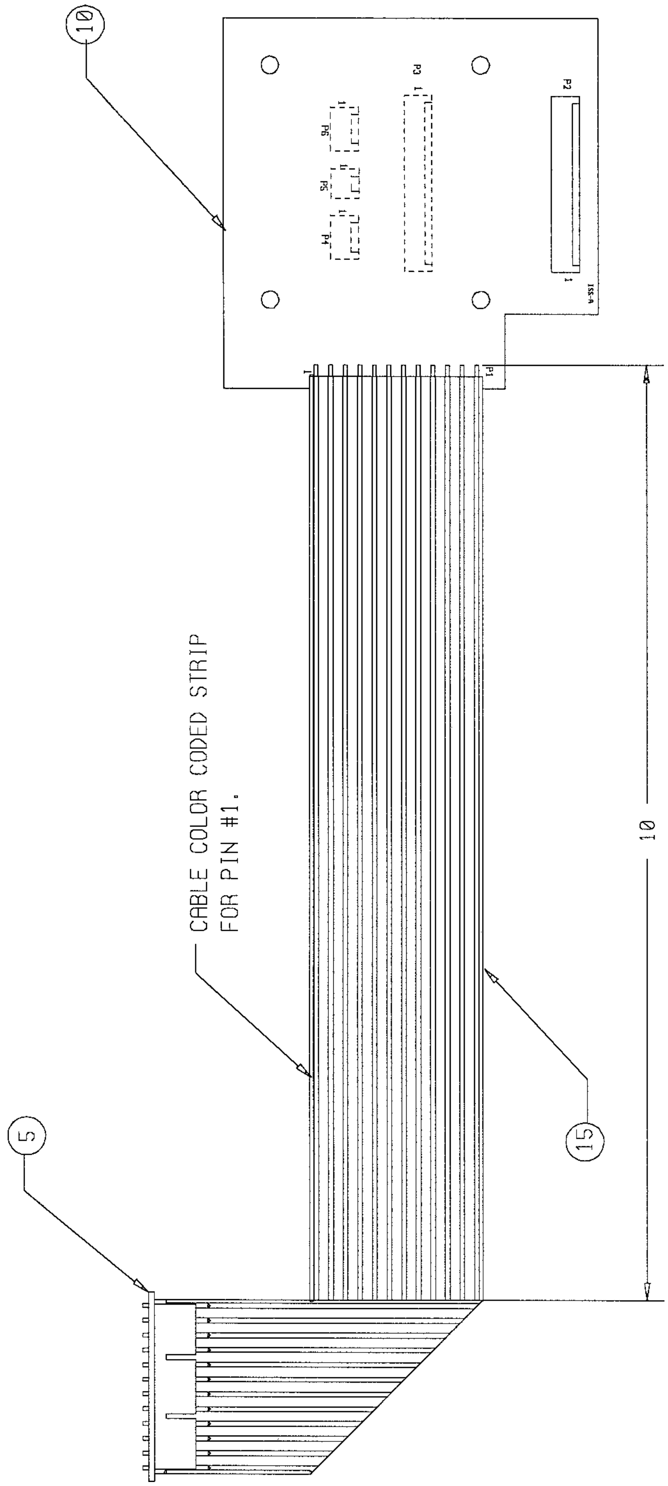
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A-7 - Cast Manifold Assembly - PN: N24604101

A.22 EOT ADAPTER ASSEMBLY (PN: N24609901)

Item No.	Description	Part Number	Quantity per Assembly
5	PCB, Connector Assy	N24700701	1
10	PCB, RF Barrier	N24701001	1
15	Cable - Ribbon 13 In	J0458510053	1



C246099

Figure A-8 - EOT Adapter Assembly - PN: N24609901

A.23 ELECTRONICS CAGE ASSEMBLY - STANDARD NICAD BATTERY TYPE (PN: N24600204)

Item No.	Description	Part Number	Quantity per Assembly
5	Cage, Electronics	N24600102	1
15	Unit, Motion Sensor	N24610101	1
20	Synthszd Radio, Prgmd N. Amer.	N24600007	1
25	PCB, EOT Display	N4519234002	1
30	Rubber Extruded Chan	A075084	1
35	Cable, Transmitter	N24600301	1
40	PCB, EOT Marker Light	N4519231601	1
45	PCB, SBU Controller	N24700901	1
50	Screw - 2-56 x 1/4 Pan Hd	J5072990104	4
55	Washer - Plate - SST No 2	J4751200104	4
60	Washer - Spring Lock No 2	J4751210103	4
65	Screw - SST 6-32 x 3/8 Pan	J5072980106	10
70	Washer - SST Plate No 6	J4751200108	10
75	Washer - SST Lock No 6	J4751210107	10
80	Adhesive - Loctite 454	J0416080005	.001
85	Bushing Strn Rlf - .300W	J705074	1
90	Screw - 4-40 x 3/8 Pan Hd	J5072970106	4
95	Washer - No 4 Flat SS	J4751200106	4
100	Washer - SST Lock No 4	J4751210105	4
105	EOT Rear Unit	N4515750627	1
110	Standoff - 4-40 x 4.250	J7927750041	2
115	PCB, EOT Display Extender	N24700601	2
125	Cable, Tie Self Lkg	J703310	1

A.24 ELECTRONICS CAGE ASSEMBLY STANDARD LEAD-ACID BATTERY TYPE (PN: N24600205)

Item No.	Description	Part Number	Quantity per Assembly
5	Cage, Electronics	N24600102	1
15	Unit, Motion Sensor	N24610101	1
20	Synthszd Radio, Prgmd N. Amer.	N24600007	1
25	PCB, EOT Display	N4519234002	1
30	Rubber Extruded Chan	A075084	1
35	Cable, Transmitter	N24600301	1
40	PCB, NS EOT Marker Light	N4519231602	1
45	PCB, SBU Controller	N24700901	1
50	Screw - 2-56 x 1/4 Pan Hd	J5072990104	4
55	Washer - Plate - SST No 2	J4751200104	4
60	Washer - Spring Lock No 2	J4751210103	4
65	Screw - SST 6-32 x 3/8 Pan	J5072980106	10
70	Washer - SST Plate No 6	J4751200108	10
75	Washer - SST Lock No 6	J4751210107	10
80	Adhesive - Loctite 454	J0416080005	.001
85	Bushing Strn Rlf - .300W	J705074	1
90	Screw - 4-40 x 3/8 Pan Hd	J5072970106	4
95	Washer - No 4 Flat SS	J4751200106	4
100	Washer - SST Lock No 4	J4751210105	4
105	Prom, EOT Pulse SBU	N4515752107	1
110	Standoff - 4-40 x 4.250	J7927750041	2
115	PCB, EOT Display Extender	N24700601	2
125	Cable, Tie Self Lkg	J703310	1

A.25 ELECTRONICS CAGE ASSEMBLY - NICAD, AUSTRALIA FREQUENCY RADIO (PN: N24600206)

Item No.	Description	Part Number	Quantity per Assembly
5	Cage, Electronics	N24600102	1
15	Unit, Motion Sensor	N24610101	1
20	Synthszd Radio, Prgmd Australia	N24600009	1
25	PCB, EOT Display	N4519234002	1
30	Rubber Extruded Chan	A075084	1
35	Cable, Transmitter	N24600301	1
40	PCB, EOT Marker Light	N4519231601	1
45	PCB, SBU Controller	N24700901	1
50	Screw - 2-56 x 1/4 Pan Hd	J5072990104	4
55	Washer - Plate - SST No 2	J4751200104	4
60	Washer - Spring Lock No 2	J4751210103	4
65	Screw - SST 6-32 x 3/8 Pan	J5072980106	10
70	Washer - SST Plate No 6	J4751200108	10
75	Washer - SST Lock No 6	J4751210107	10
80	Adhesive - Loctite 454	J0416080005	.001
85	Bushing Strn Rlf - .300W	J705074	1
90	Screw - 4-40 x 3/8 Pan Hd	J5072970106	4
95	Washer - No 4 Flat SS	J4751200106	4
100	Washer - SST Lock No 4	J4751210105	4
105	EOT Rear Unit	N4515750627	1
110	Standoff - 4-40 x 4.250	J7927750041	2
115	PCB, EOT Display Extender	N24700601	2
125	Cable, Tie Self Lkg	J703310	1

A.26 ELECTRONICS CAGE ASSEMBLY - NICAD, ORANGE COMPOSITE TYPE (PN: N24600208)

Item No.	Description	Part Number	Quantity per Assembly
5	Cage, Electronics	N24600102	1
15	Unit, Motion Sensor	N24610101	1
20	Synthszd Radio, Prgmd N. Amer.	N24600007	1
25	PCB, EOT Display	N4519234002	1
30	Rubber Extruded Chan	A075084	1
35	Cable, Transmitter	N24600301	1
40	PCB, EOT Marker Light	N4519231601	1
45	PCB, SBU Controller	N24700901	1
50	Screw - 2-56 x 1/4 Pan Hd	J5072990104	4
55	Washer - Plate - SST No 2	J4751200104	4
60	Washer - Spring Lock No 2	J4751210103	4
65	Screw - SST 6-32 x 3/8 Pan	J5072980106	10
70	Washer - SST Plate No 6	J4751200108	10
75	Washer - SST Lock No 6	J4751210107	10
80	Adhesive - Loctite 454	J0416080005	.001
85	Bushing Strn Rlf - .300W	J705074	1
90	Screw - 4-40 x 3/8 Pan Hd	J5072970106	4
95	Washer - No 4 Flat SS	J4751200106	4
100	Washer - SST Lock No 4	J4751210105	4
105	EOT Rear Unit	N4515750627	1
110	Standoff - 4-40 x 4.250	J7927750041	2
115	PCB, EOT Display Extender	N24700601	2
125	Cable, Tie Self Lkg	J703310	1

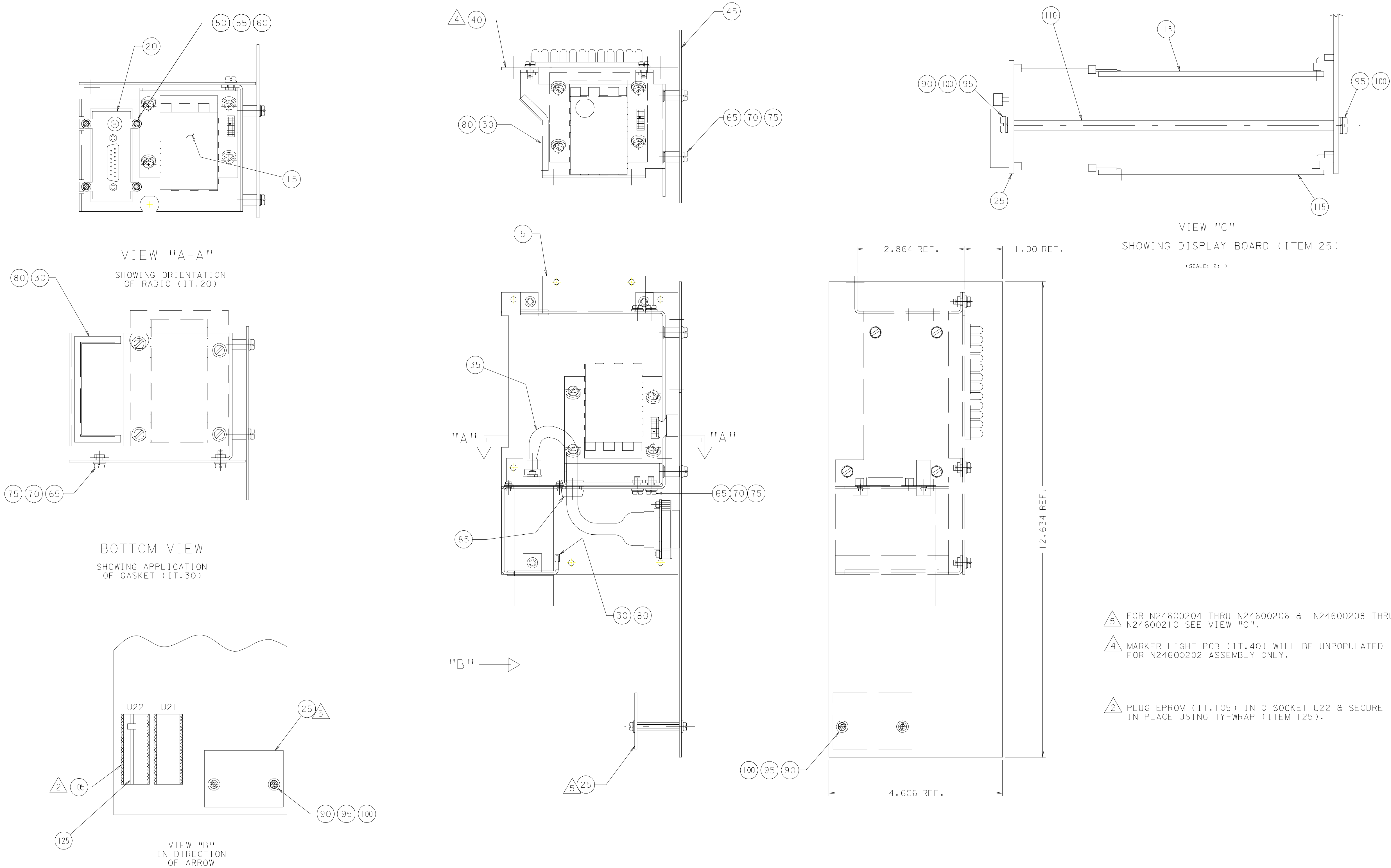


Figure A-9 - Electronics Cage Assembly (Standard NiCAD Battery Type) - PN: N24600204
Standard Lead-Acid Battery Type - PN: N24600205
NiCAD, Australia Frequency Radio - PN: N24600206
NiCAD, Orange Composite Type - PN: N24600208

DWG NO: F246002

A.27 PCB, SBU CONTROLLER (PN: N24700901)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Board - PC Smt EOT SBU Cont	J7766140017	1
5	R76	Res - Smt .499 Ohm 1W	J7355522000	1
10	R59	Res - Smd 1/8 W 121 Ohm	J7355520204	1
15	R27, R51	Res - Smd 1/8 W 200 Ohm	J7355520225	2
20	R60	Res - Smd 1/8 W 442 Ohm	J7355520258	1
25	R14, R55, R56	Res - Smd 1/8 W 1.0 MegOhm	J7355520580	3
30	R61	Res - Smd 1/8 W 1.10K Ohm	J7355520296	1
35	R36, R94, R95, R96, R97, R99	Jumper - Smt 0 Ohm Res	J7355522004	6
40	R4, R1, R11, R12, R16, R17, R18, R21, R22, R23, R24, R28, R29, R31, R32, R34, R42, R48, R53, R54, R57, R63, R68, R72, R74, R77, R78, R79, R93	Res - Smd 1/8 W 100.0K Ohm	J7355520484	30
45	R2, R7, R8, R9, R10, R13, R58, R87, R89, R90, R100	Res - Smd 1/8 W 10K Ohm	J7355520388	11
50	R30, R49	Res - Smd 1/8 W 140K Ohm	J7355520498	2
55	R44	Res - Smd 1/8 W 3.57K Ohm	J7355520345	1
60	R86	Res - Smd 1/8 W 162K Ohm	J7355520504	1
65	R20, R88	Res - Smd 1/8 W 1000 Ohm	J7355520292	2
70	R81	Res - Smt 10 Meg 1/8 W	J7355522002	1
75	R38, R45, R46	Res - Smd 1/8 W 2.80K Ohm	J7355520335	3
80	R83	Res - Smd 1/8 W 20.0K Ohm	J7355520417	1
90	R19	Res - Smd 1/8 W 2.00K Ohm	J7355520321	1
95	R5, R6, R25, R26, R80, R91, R92	Res - Smd 1/8 W 332K Ohm	J7355520534	7
100	R3	Res - Smd 1/8 W 4.53K Ohm	J7355520355	1
105	R84	Res - Smd 1/8 W 40.2K Ohm	J7355520446	1
110	R75	Res - Smd 1/8 W 44.2K Ohm	J7355520450	1
115	R66, R73, R65	Res - Smd 1/8 W 49.9K Ohm	J7355520455	3
120	R69	Res - Smd 1/8 W 63.4K Ohm	J7355520465	1
130	R85	Res - Smd 1/8 W 80.6K Ohm	J7355520475	1
135	R15	Res - Smd 1/8 W 86.6K Ohm	J7355520478	1
140	R71	Res - Smd 1/8 W 33.2K Ohm	J7355520438	1
145	R67	Res - Smd 1/8 W 523K Ohm	J7355520553	1
150	R62	Pot - Smt 500 Ohm .25W	J6208500134	1
155	RN1	Res - Smt, Network 100K	J7355530005	1

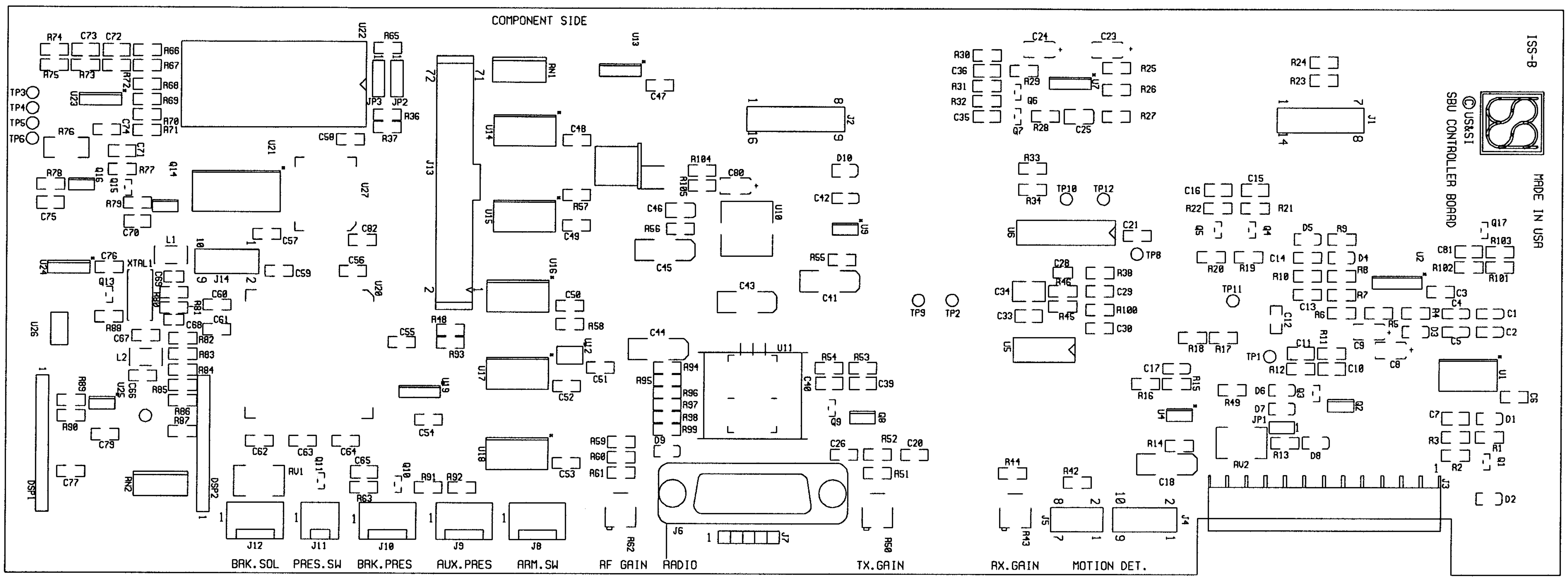
A.27 PCB, SBU Controller (PN: N24700901) (Continued)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
160	RN2	Res - Smt, Network 10K	J7355530004	1
165	C29	Capac - .047 MFD Smt	J7091530010	1
170	C28	Capac - .001 MFD Smt	J7091530014	1
175	C34	Capac - .33 MFD Smt	J7091530013	1
180	C13, C14, C20, C26, C30, C66, C67	Capac - .1 UF, 50V	J7091530003	7
185	C3, C12, C6, C21, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61, C62, C63, C64, C74, C77, C76, C79, C82	Capac - .1 MFD Smt	J7091530012	27
190	C18, C41, C43, C44, C45	Capac - 10 MFD 25V Smt	J7091530020	5
195	C1, C2, C4, C5, C17, C42	Capac - 1 MFD 20VDC Smt	J7091530016	6
200	C68, C69	Capac - 22 PF Smt	J7091530015	2
205	C25	Capac - 2.2 MFD 20V Smt	J7091530017	1
210	C46	Capac - 3.3 MFD 20V Smt	J7091530018	1
215	C8, C9, C23, C24	Capac - 6.8 MFD 20V Smt	J7091530019	4
220	D1, D2, D3, D7, D6, D8, D9	Diode - Smt 4001	J7261020003	7
225	D4, D5	Diode - Smt 5818 Schottky	J7261020004	2
230	U20	Int Ckt - 68HC16Z1CFC16	J7150290691	1
235	U19	Int Ckt - Smt, 74HC02	J7150340014	1
240	U24	Int Ckt - Smt, 74HC04	J7150340016	1
245	U13	Int Ckt - Smt, 74HC32	J7150340018	1
250	U14, U15	Int Ckt - Smt, 74HC541	J7150340022	2
255	U16, U17, U18	Int Ckt - Smt, 74HC573	J7150340023	3
260	U22	Socket, Int Ckt 28 Pin	J7258400002	1
265	U25	Int Ckt - Smt, EEPROM 2K	J7150340048	1
270	U7	Int Ckt - Smt 4093	J7150340049	1
275	U26	Int Ckt - Smt, D1233Z	J7150340008	1
280	U12	Int Ckt - Smt, DS1620	J7150340054	1
285	U5	Int Ckt - LT1013IN8	J7150290745	1
290	U6	Int Ckt - LT1079IN	J7150290735	1
295	U4	Int Ckt - Smt, LT1121S8	J7150340045	1
300	U9	Int Ckt - Smt, LT1121IS8-5	J7150340044	1

A.27 PCB, SBU CONTROLLER (PN: N24700901) (CONTINUED)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
305	U10	Int Ckt - Smt, LT1129IQ-5	J7150340046	1
315	U1	Int Ckt - Smt, LT1280IS	J7150340047	1
320	U2	Int Ckt - Smt, MC14538B	J7150340050	1
325	U23	Int Ckt - Smt, 3704	J7150340052	1
330	U11	Int Ckt - LT1085IT	J7150290733	1
335	Q4	Xstr - Smt VP0610T P-MOSFET	J7313760006	1
340	Q16	Xstr - SI9410 PWR-MOSFET	J7313760005	1
345	Q2, Q8, Q14	Xstr - SI9435 PWR-MOSFET	J7313760004	3
350	Q1, Q3, Q5, Q6, Q7, Q15, Q9, Q10, Q11, Q13	Xstr - VN VN0605T MOSFET	J7313760007	10
360	L1, L2	Inductor - 10 UH Smt	J7034850010	2
365	RV1, RV2	Varis - 22 VDC Smd	J7355500012	2
370	XTAL1	XTAL - 32.768 Khz Smt	J7032130003	1
375	J7	Header - 36 Pos	J7091460800	.150
380	J2	Term Strip - 16 Pin	J7091460844	1
385	J1	Term Strip - 14 Pin	J7091460843	1
390	J4	Term Strip - 10 Pin	J7091460819	1
395	J6	Conn - DB15 PCB Female	J7091460846	1
400	J13	Conn - Hdr Brd To Brd	J7091460849	1
405	J8, J10, J12, J9	Conn - Hdr 3 Pos	J7091460833	4
410	J11	Conn - Hdr 2 Pos	J7091460832	1
415	J3	Conn - 12 Pos PCB Mnt	J7091460834	1
435	U11	Screw - 4-40 x 3/8 Rd Hd Steel	J525074	1
440	U11	Nut - 4-40 Hex Steel	J480006	1
445	U11	Insul - Pad to-220	J7721190005	1
450	U11	Washer - No 4 Lock SS	J047765	1
455	DSP1, DSP2	Conn - Pos Socket	J7091460858	2
465	R50	Pot - Smt 2K Ohm	J6208500149	1
470	R43	Pot - Smt 20K Ohm .25W	J6208500135	1
480	C7, C10, C11, C15, C16, C33, C35, C36, C39, C40, C65, C70, C71, C72, C73, C75, C81	Capac - .01 MFD Smt	J7091530011	17
485	R82	Res - Smd 1/8 W 324K Ohm	J7355520533	1
490	R70	Res - Smd 1/8 W 9.53K Ohm	J7355520386	1
500	D10	Diode - Smt MMSZ5232BT1	J7261020006	1
505	J6	Washer - No 4 Flat SS	J4751200106	2
510	J6	Washer - SST Lock No 4	J4751210105	2
515	J6	Screw - 4-40 x 3/8 Pan Hd	J5072970106	2

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⚠ For Component Part Number Refs, See Parts List

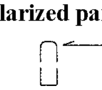
-- After all components are mounted, treat per PY-9368-1 (Spraycoat) all over using the following precautions:
(A) Mask off connectors J1 through J13, DSP1 & DSP2, potentiometers R43, R50, R62, and all IC sockets.

-- On connector J8, clip off top of pin 1 flush with connector as shown in View "B"

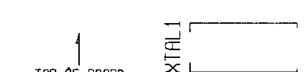
-- On connector J12, clip off top of pin 2 flush with connector as shown in View "B"

-- Connectors J5, J14, Jumpers JP1, JP2, JP3, andU21 not used at this time. Mask J5 during wave soldering and reflow

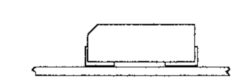
-- Polarized part outline shown below:


Chamfered edge denotes positive end of capacitors and cathode end of diodes

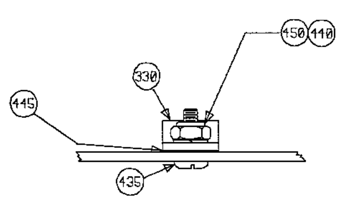
-- Crystal (XTAL1) to be installed oriented as shown:



Position component with notched edge toward designation "XTAL1" (left side of board)

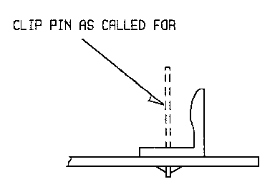


-- Install Connector J6 per View "C"



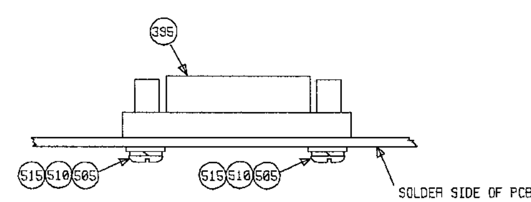
VIEW SHOWING MOUNTING LT1085 WITH HEATSINK

VIEW "A"



VIEW SHOWING PIN REMOVAL ON CONNECTORS

VIEW "B"



VIEW SHOWING DB15 CONNECTOR MOUNTING TO BOARD

VIEW "C"

DWG NO: 247009

Figure A-10 - SBU Controller PCB Assembly, PN: N24700901

Drawing # 247009K (1 of 2)

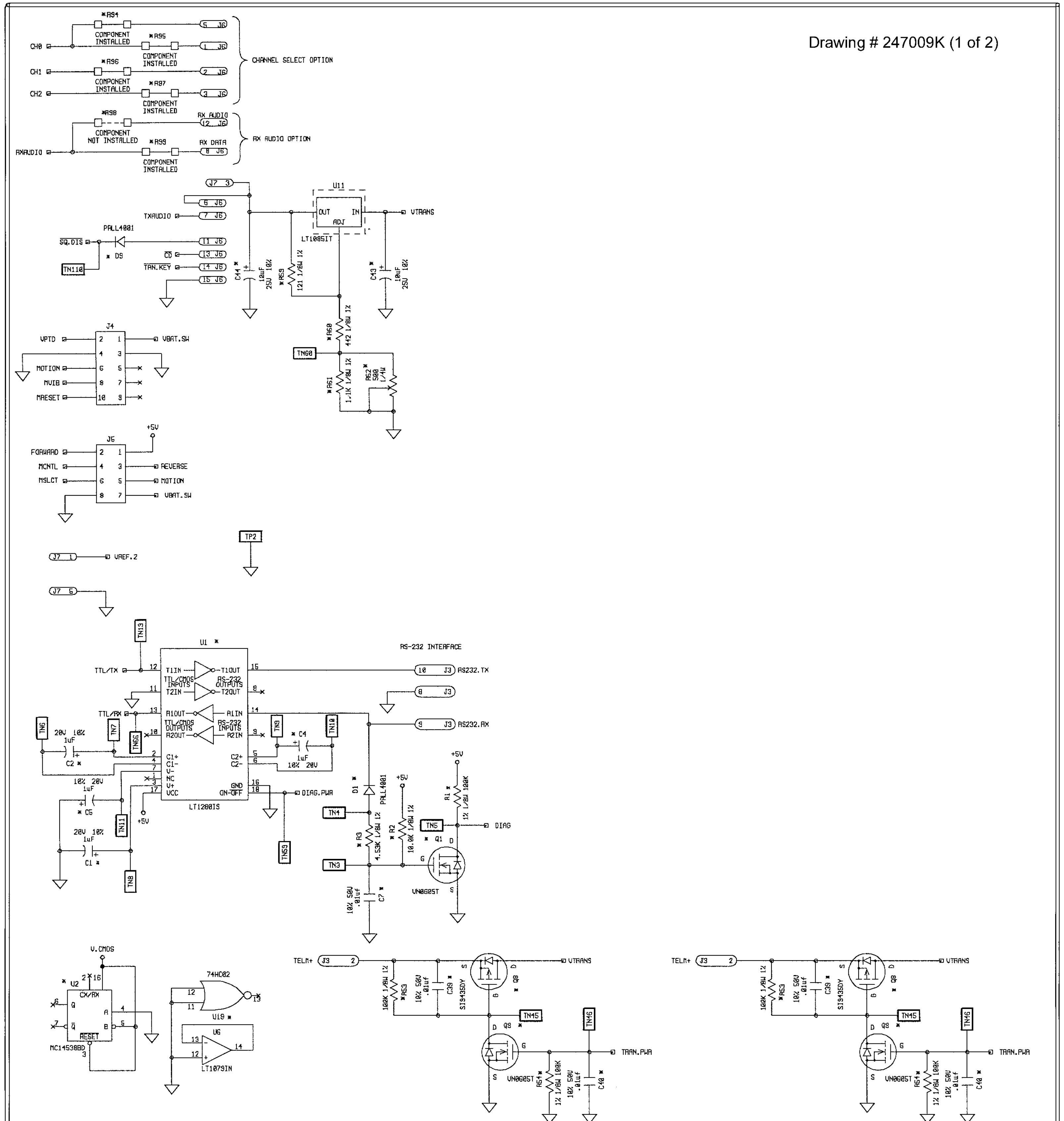


Figure A-11 - SBU Controller PCB Schematic, PN: N24700901

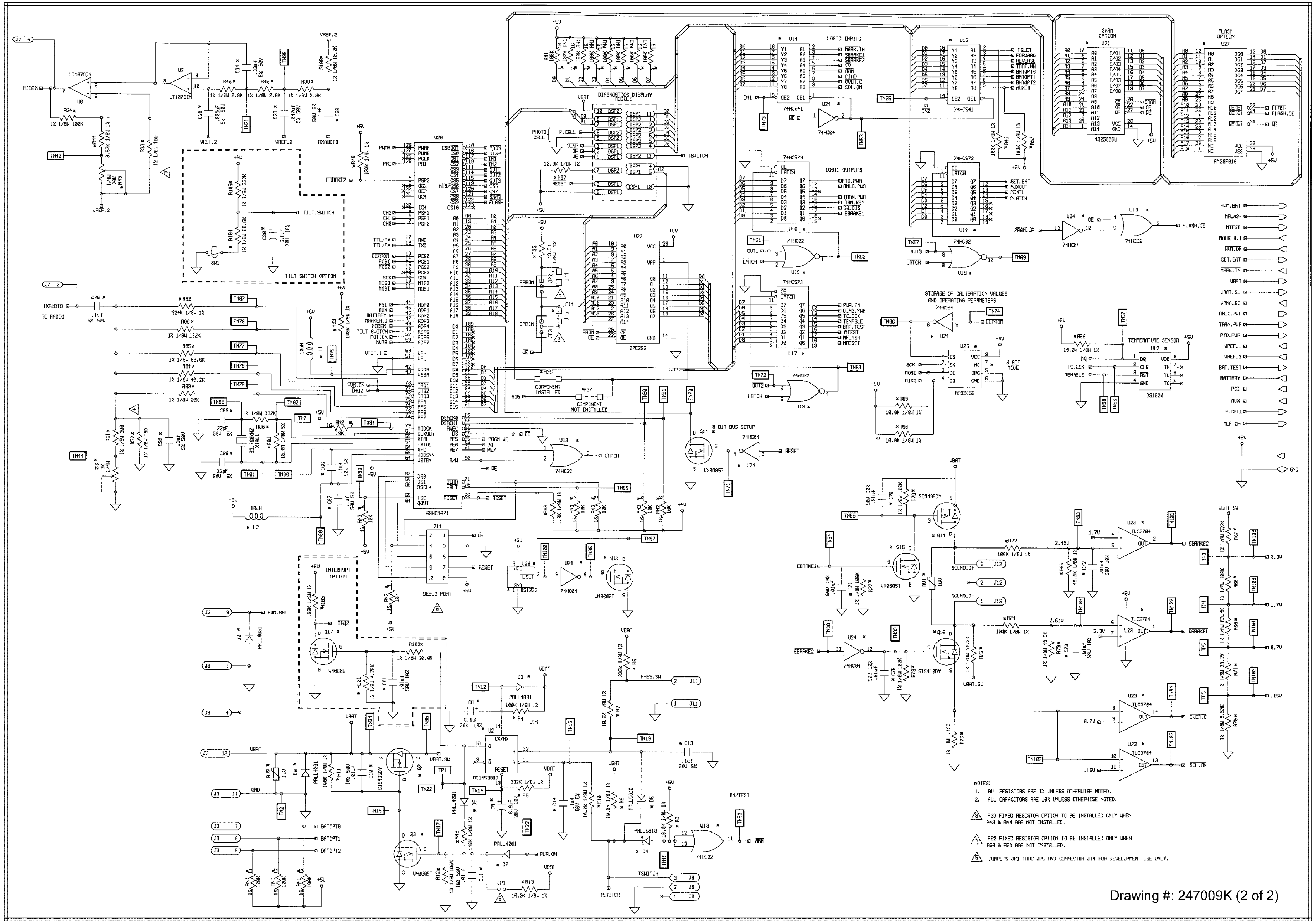
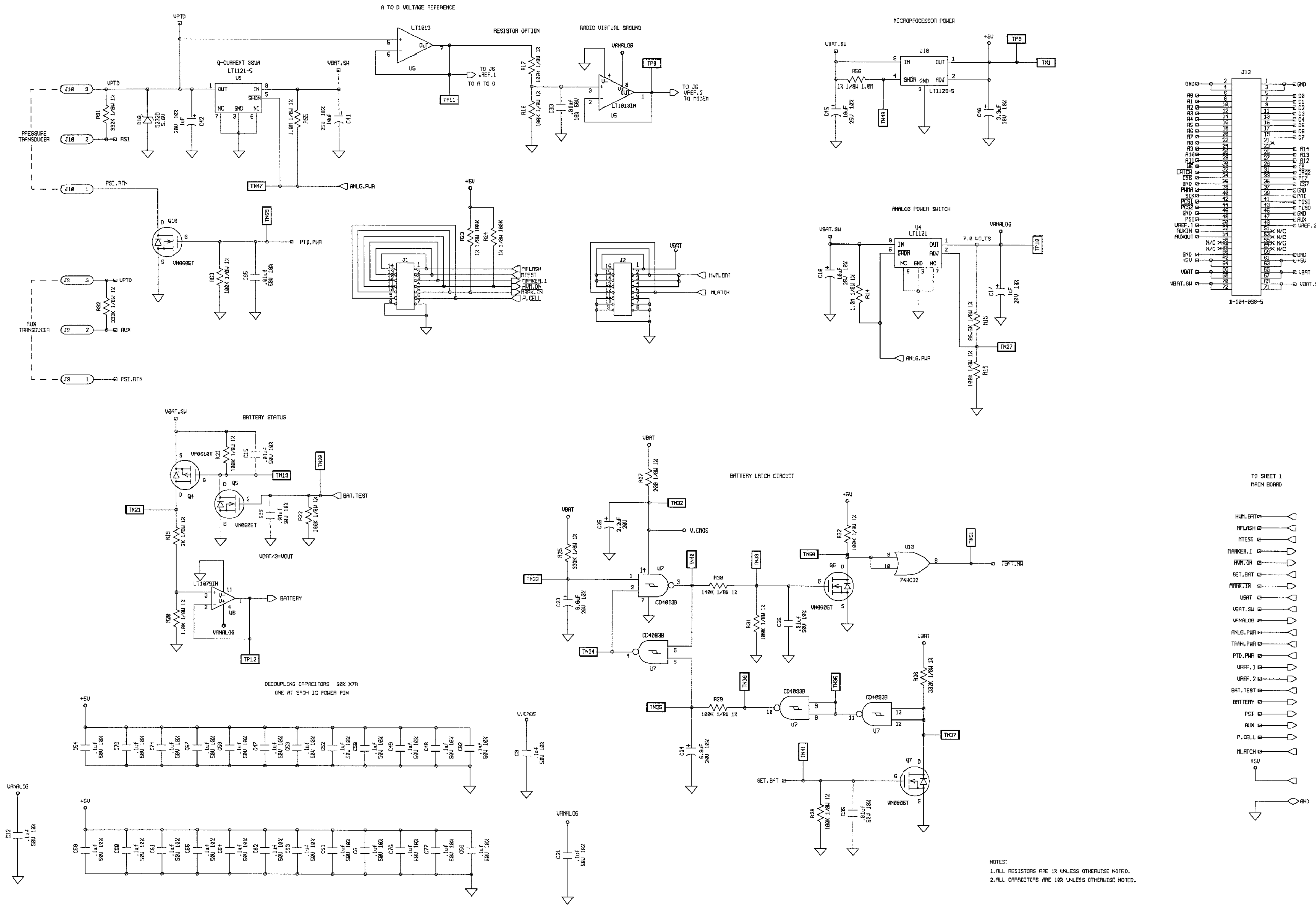


Figure A-11 - SBU Controller PCB Schematic, PN: N24700901

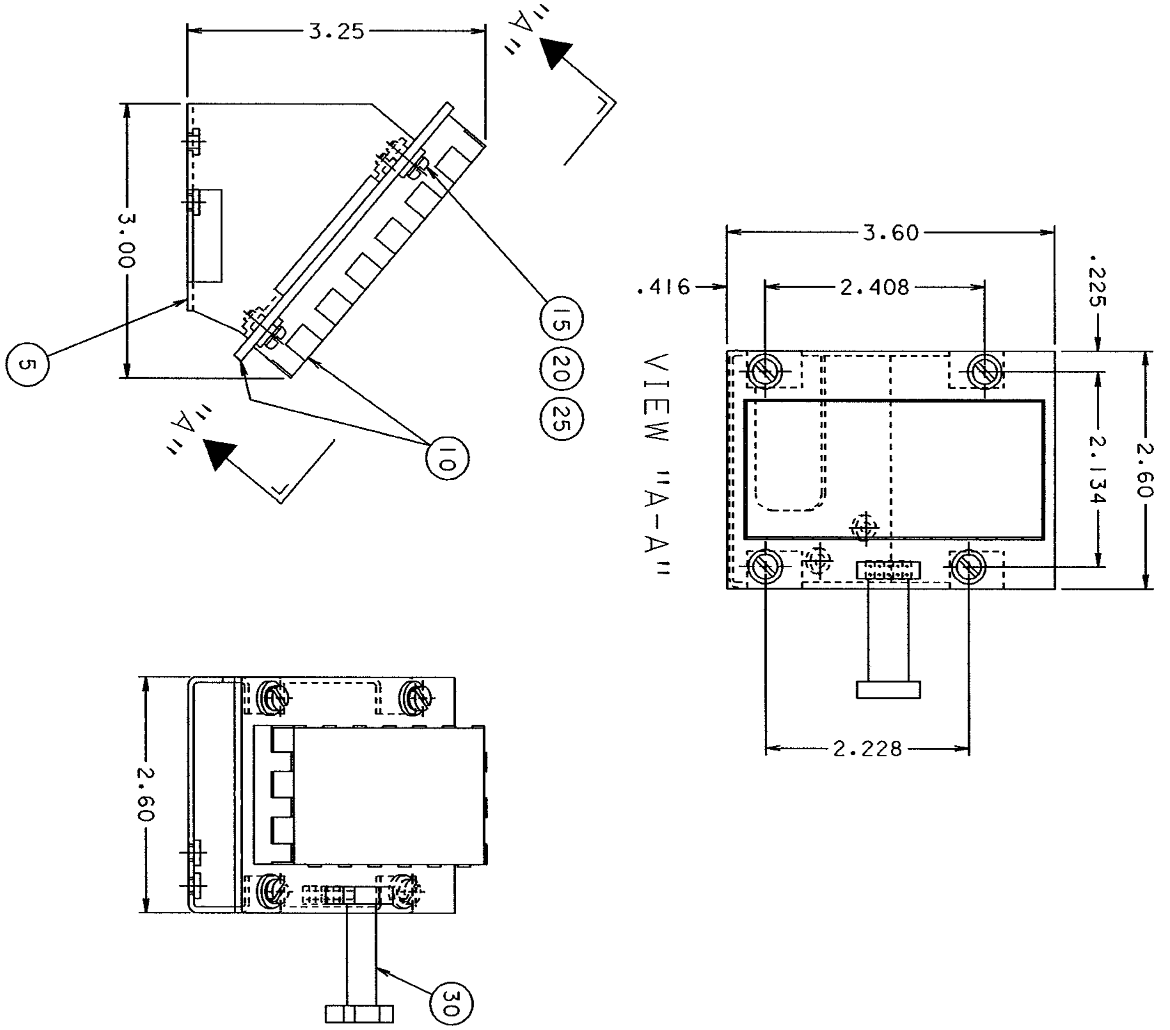


D247009L

Figure A-11 - SBU Controller PCB Schematic, PN: N24700901

A.28 UNIT, MOTION SENSOR (PN: N24610101)

Item No.	Description	Part Number	Quantity per Assembly
5	Motion Sensor Mtg Bracket	N24609602	1
10	PCB, Motion Sensor	N24700501	1
15	Screw - 6-32 x 3/8 Pan	J5072980106	4
20	Washer - SST Plate No 6	J4751200108	4
25	Washer - SST Lock No 6	J4751210107	4
30	Cable, Ribbon	N24610001	1



C246 Sh. 101

Figure A-12 - Motion Sensor Unit PN: N24610101

A.29 PCB, MOTION SENSOR (PN: N24700501)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - EOT Motion Sensor Smt	J776616884	1
5	J2	Term Strip - 6 Pin	J7091461005	1
10	L1	Choke - Vk 200 20/4B	J709602	1
15	J1	Term Str-10 Pin TSW-105-25	J7091461093	1
20	R6	Res - Smd 1/8 W 26.7K Ohm	J7355520429	1
25	R4	Res - Smd 1/8 W 301K Ohm	J7355520530	1
30	R3, R10, R11	Res - Smd 1/8 W 10K Ohm	J7355520388	3
35	R9	Res - Smd 1/8 W 511 Ohm	J7355520264	1
40	R1, R2, R5, R12, R13, R14	Res - Smd 1/8 W 100.0K Ohm	J7355520484	6
45	C1, C5, C6, C7	Capac - Smt, .1UF, 50V	J7091530003	4
50	C8, C9	Capac - Smt, .022 MFD, 50V	J7091530033	2
55	C3	Capac - Smt, 10 PF, 100V	J7091530035	1
60	C4	Capac - Smt, 15 PF, 100V	J7091530034	1
65	Q1, Q3, Q4	XSTR - VN VN0605T MOSFET	J7313760007	3
70	Q2	XSTR - SI9435 Pwr MOSFET	J7313760004	1
75	LED2, LED3	Diode - Smt LED Red	J7261020010	2
80	U2	Int Ckt - PIC16C74-04I/P	J7150290797	1
85	U2	Socket - Int Ckt 40 Pin	J7258400051	1
90	XTL1	Crystal - Smt 1 Mhz	J7032130008	1
95	LED1	Diode - Smt LED Green	J7261020011	1
100	R15	Pot - Smt 50K Ohm 15 Turn	J6208500147	1
105	JP1, JP2	Term Strip - TSW-102-23-G-S	J7091461086	2
110	JP1	Jack - Shorting Snt-100-BK-G-H	J7133060031	1
115	C10, C11	Capac - 47 PF 100 VDC Smt	J7091530021	2
120	C2, C12	Capac - .001 MFD Smt	J7091530014	2
125	U1	Int Ckt - Acceler ADXL05AH	J7150290788	1
130	U1	Pad - IC Mntg 10 Lead	J7721190011	1
135	--	Enclosure-Shielded	J7051890009	1

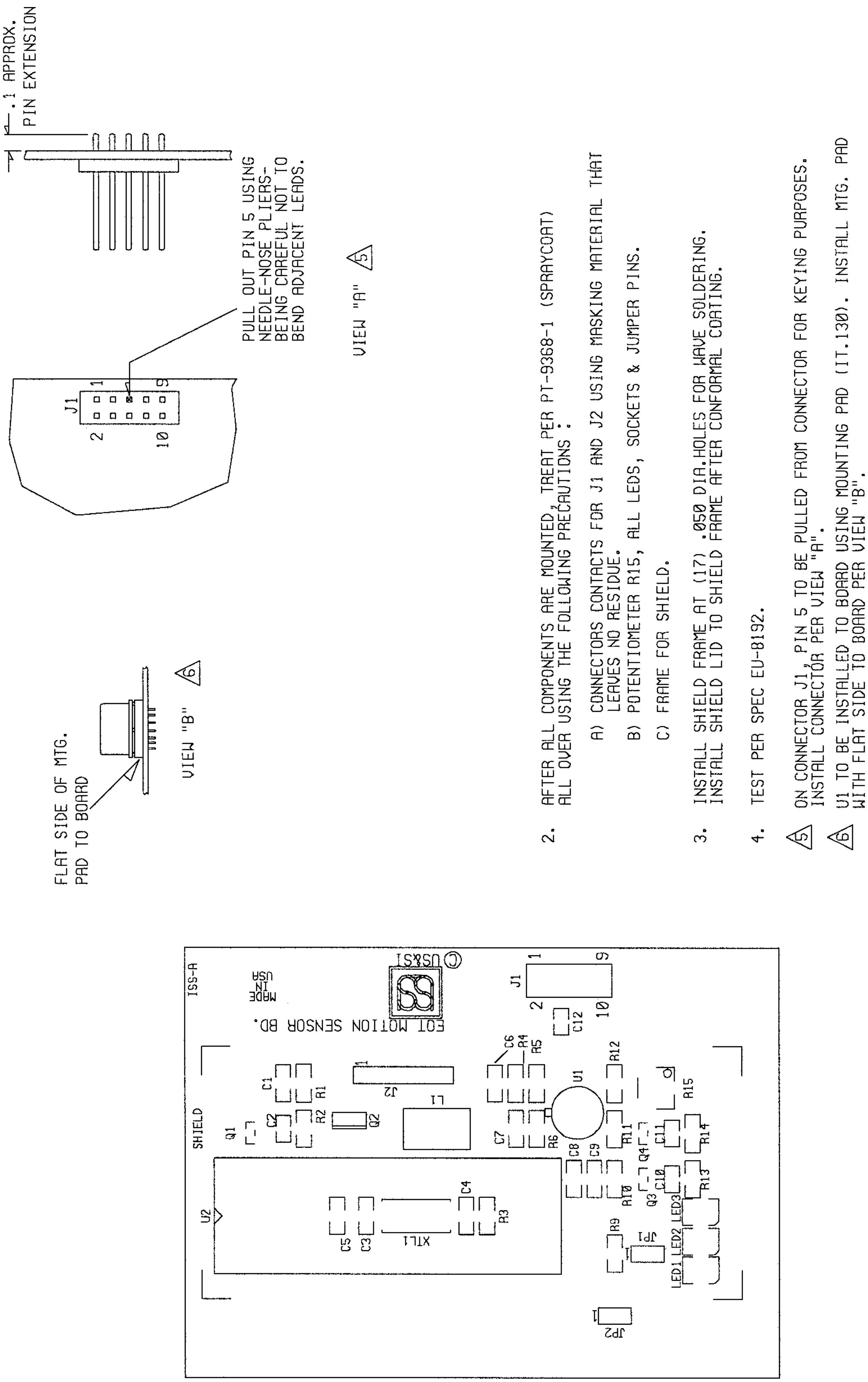
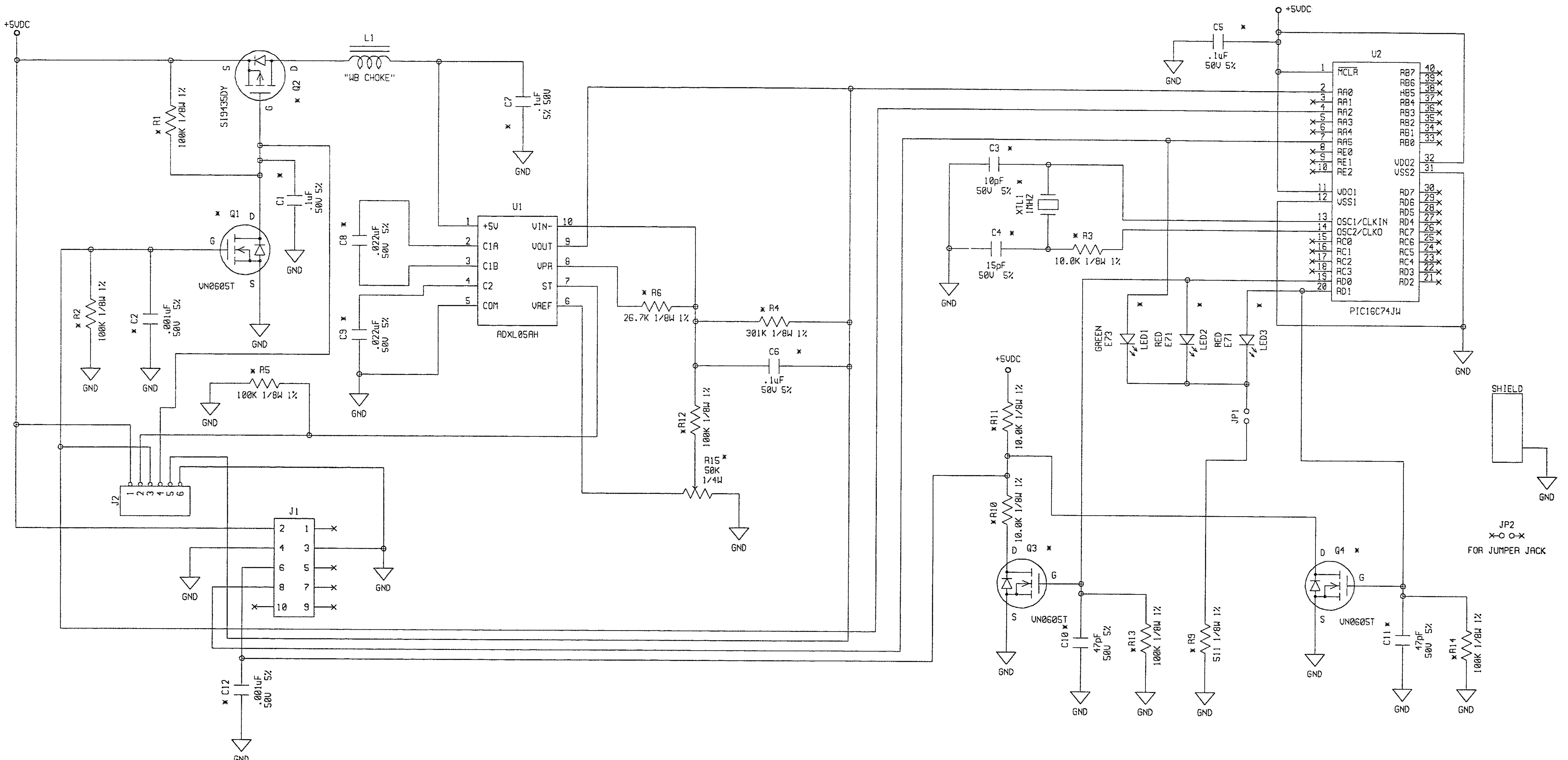


Figure A-13 - Motion Sensor PCB PN: N24700501 **247 Sh. 005**

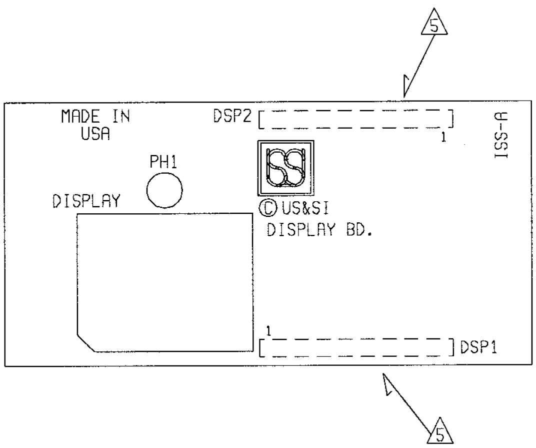


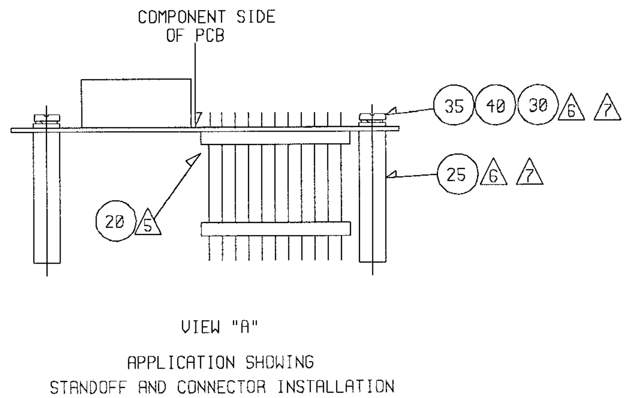
247005F

Figure A-14 - Motion Sensor PCB Schematic PN: N24700501

A.30   PCB, EOT DISPLAY (PN: N4519234002)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC EOT Display	J776616785	1
5	Display	Int Ckt - Hdls-2416	J7150290732	1
10	PH1	Res - Light Dependent	J792585016	1
15	PH1	Spacer - LED .092”	J7927750025	1
20	DSP1, DSP2	Conn - 11 Pos Term Strip	J7091460857	2





1. FOR COMPONENT PART NUMBER REFS, SEE COMPUTER BM.
2. FOR SCHEMATIC DIAGRAM SEE B451923-SH.40E.
3. TEST PER SPEC EU-8044
4. AFTER ALL COMPONENTS ARE MOUNTED, TREAT PER PT-9368-1 (SPRAYCOAT) ALL OVER USING THE FOLLOWING PRECAUTIONS :
   A) MASK PHOTOCELL PH1, DISPLAY, AND CONNECTORS DSP1 & DSP2 USING MASKING MATERIAL THAT LEAVES NO RESIDUE.
5. CONNECTORS DSP1 & DSP2 TO BE MOUNTED ON SOLDER SIDE OF PCB PER VIEW "A".
6. MOUNT STANDOFFS IT.25 ON SOLDER SIDE OF PCB PER VIEW "A" USING HARDWARE AS CALLED FOR ON N4519234001 ASSEMBLY ONLY.
7. ITEMS 25, 30, 35 & 40 ARE NOT INSTALLED ON N4519234002 ASSEMBLY.

Figure A-15 - EOT Display PCB - PN: N4519234002

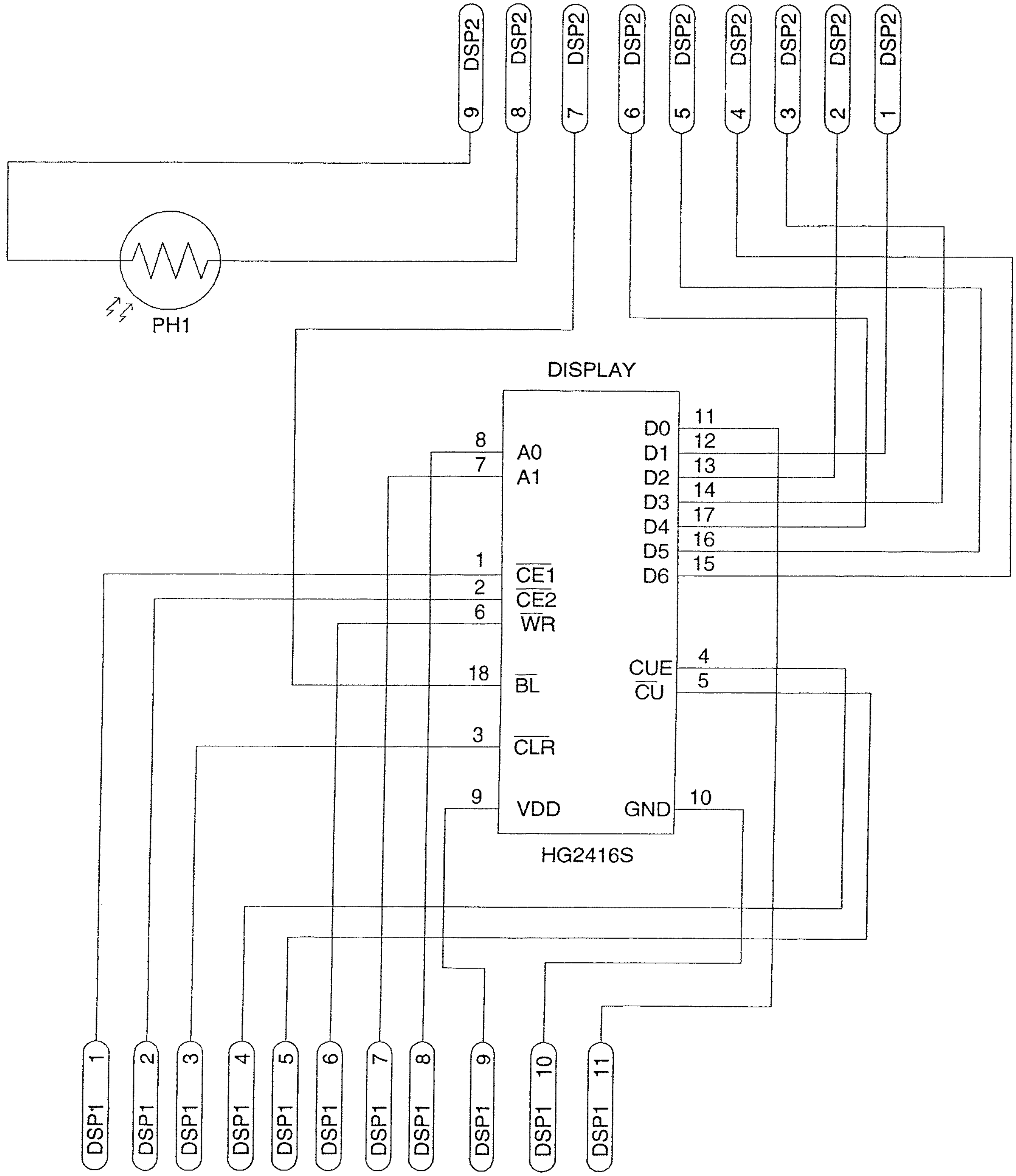


Figure A-15 (Continued) - EOT Display PCB - PN: N4519234002

A.31 PCB, EOT MARKER LIGHT NICAD TYPE SBU (PN: N4519231601)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC Smt EOT Marker Light	J7766140002	1
5	R37	Res - Smt .499 Ohm 1W	J7355522000	1
10	R1 thru R36	Res - Smt 162 Ohm 1/4W	J7355522001	36
15	R66	Pot - 100K Ohm 1/2W	J6208500086	1
20	R56, R54, R44, R39, R43, R62, R38, R45, R64, R40, R52	Res - Smd 1/8 W 100.0K Ohm	J7355520484	11
25	R46	Res - Smd 1/8 W 16.2K Ohm	J7355520408	1
30	R42	Varis - 22 VDC Smd	J7355500012	1
35	R47	Res - Smd 1/8 W 1000 Ohm	J7355520292	1
40	R58	Res - Smd 1/8 W 1.0 MegOhm	J7355520580	1
45	R53	Res - Smd 1/8 W 200 Ohm	J7355520225	1
50	R60	Res - Smd 1/8 W 33.2K Ohm	J7355520438	1
55	R55, R57, R48, R59	Res - Smd 1/8 W 332K Ohm	J07355520534	4
60	R41	Res - Smd 1/8 W 511K Ohm	J7355520552	1
65	R65	Res - Smd 1/8 W 768K Ohm	J7355520569	1
70	R63, R67	Res - Smd 1/8 W 71.5K Ohm	J7355520470	2
75	R50	Res - Smd 1/8 W 140K Ohm	J7355520498	1
80	R49	Res - Smd 1/8 W 8.06K Ohm	J7355520379	1
85	R51	Res - Smd 1/8 W 665K Ohm	J7355520563	1
90	R61	Res - Smd 1/8 W 681K Ohm	J7355520564	1
95	C1, C3, C6, C8, C9, C10, C12, C17, C18	Capac - .01 MFD Smt	J7091530011	9
100	C13, C7, C19, C5, C16, C20, C15	Capac - .1 MFD Smt	J7091530012	7
105	C21	Capac - 2 MFD 50 VDC	J7091450902	1
110	C11	Capac - 2.2 MFD 20V Smt	J7091530017	1
115	C4, C14	Capac - 6.8 MFD 20V Smt	J7091530019	2
125	D1, D2, D8, D4, D5, D6, D7, D10, D11	Diode - Smt 4001	J7261020003	9
130	D3	Diode - Smt, Zener, 5.1V	J7261020001	1
135	DS1 thru DS144	Diode - LED Red HLMP8103	J7261500293	144
140	U1	Int Ckt - LT1178IN	J7150290734	1
145	U2	Int Ckt - Smt 4093	J7150340049	1

A.31 PCB, EOT MARKER LIGHT NICAD TYPE SBU (PN: N4519231601) (CONTINUED)

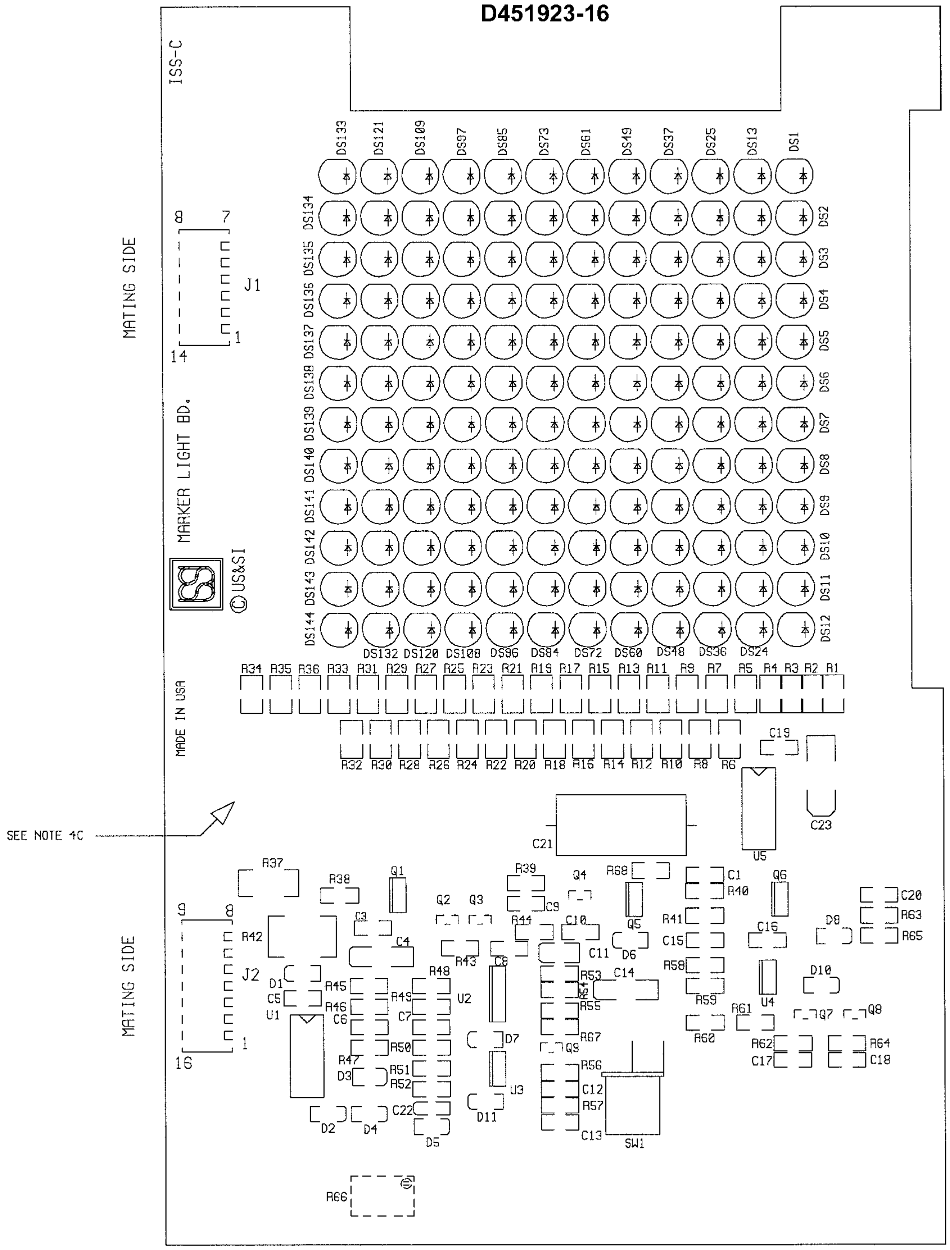
	Item No.	Description	Part Number	Quantity per Assembly
150	U4	Int Ckt - Smt 3702 CMOS	J7150340051	1
155	U5	Int Ckt - ICM7555 MJA	J7150290737	1
160	U3	Int Ckt - Smt MAX8211ESA	J7150340053	1
165	Q7	XSTR-Smt VP0610T P-MOSFET	J7313760006	1
170	Q5, Q6, Q1	XSTR-SI9435 P-MOSFET	J7313760004	3
175	Q9, Q4, Q3, Q8, Q2	XSTR-VN VN0605T MOSFET	J7313760007	5
180	SW1	Switch - Tilt Mercury HVM	330-0009-00	1
185	J2	Conn - Rt Angle 16 Pin	J7091460848	1
190	J1	Conn - Rt Angle 14 Pin	J7091460845	1
195	C22	Capac - 1 MFD 20 VDC Smt	J7091530016	1
200	C23	Capac - 10 MFD 25V Smt	J7091530020	1
205	R68	Res - Smd 1/8 W 10K Ohm	J7355520388	1

A.32 PCB, EOT MARKER LIGHT LEAD-ACID TYPE SBU (PN: N4519231602)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC Smt EOT Marker Light	J7766140002	1
5	R37	Res - Smt .499 Ohm 1W	J7355522000	1
10	R1 thru R36	Res - Smt 162 Ohm 1/4W	J7355522001	36
15	R66	Pot - 100K Ohm 1/2W	J6208500086	1
20	R56, R54, R44, R39, R43, R62, R38, R45, R64, R40, R52	Res - Smd 1/8 W 100.0K Ohm	J7355520484	11
25	R46	Res - Smd 1/8 W 16.2K Ohm	J7355520408	1
30	R42	Varis - 22 VDC Smd	J7355500012	1
35	R47	Res - Smd 1/8 W 1000 Ohm	J7355520292	1
40	R58	Res - Smd 1/8 W 1.0 MegOhm	J7355520580	1
45	R53	Res - Smd 1/8 W 200 Ohm	J7355520225	1
50	R60	Res - Smd 1/8 W 33.2K Ohm	J7355520438	1
55	R55, R57, R48, R59	Res - Smd 1/8 W 332K Ohm	J07355520534	4
60	R41	Res - Smd 1/8 W 511K Ohm	J7355520552	1
65	R65	Res - Smd 1/8 W 768K Ohm	J7355520569	1
70	R63, R67	Res - Smd 1/8 W 71.5K Ohm	J7355520470	2
75	R50	Res - Smd 1/8 W 64.9K Ohm	J7355520466	1
80	R49	Res - Smd 1/8 W 2.67K Ohm	J7355520333	1
85	R51	Res - Smd 1/8 W 806K Ohm	J7355520571	1
90	R61	Res - Smd 1/8 W 681K Ohm	J7355520564	1
95	C1, C3, C6, C8, C9, C10, C12, C17, C18	Capac - .01 MFD Smt	J7091530011	9
100	C13, C7, C19, C5, C16, C20, C15	Capac - .1 MFD Smt	J7091530012	7
105	C21	Capac - 2 MFD 50 VDC	J7091450902	1
110	C11	Capac - 2.2 MFD 20V Smt	J7091530017	1
115	C4, C14	Capac - 6.8 MFD 20V Smt	J7091530019	2
125	D1, D2, D8, D4, D5, D6, D7, D10, D11	Diode - Smt 4001	J7261020003	9
130	D3	Diode - Smt, Zener, 5.1V	J7261020001	1
135	DS1 thru DS144	Diode - LED Red HLMP8103	J7261500293	144
140	U1	Int Ckt - LT1178IN	J7150290734	1
145	U2	Int Ckt - Smt 4093	J7150340049	1
150	U4	Int Ckt - Smt 3702 CMOS	J7150340051	1
155	U5	Int Ckt - ICM7555 MJA	J7150290737	1
160	U3	Int Ckt - Smt MAX8211ESA	J7150340053	1

A.32 PCB, EOT MARKER LIGHT LEAD-ACID TYPE SBU(PN: N4519231602) (CONTINUED)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
165	Q7	XSTR-Smt VP0610T P-MOSFET	J7313760006	1
170	Q5, Q6, Q1	XSTR-SI9435 P-MOSFET	J7313760004	3
175	Q9, Q4, Q3, Q8, Q2	XSTR-VN VN0605T MOSFET	J7313760007	5
180	SW1	Switch - Tilt Mercury HVM	330-0009-00	1
185	J2	Conn - Rt Angle 16 Pin	J7091460848	1
190	J1	Conn - Rt Angle 14 Pin	J7091460845	1
195	C22	Capac - 1 MFD 20 VDC Smt	J7091530016	1
200	C23	Capac - 10 MFD 25V Smt	J7091530020	1
205	R68	Res - Smd 1/8 W 10K Ohm	J7355520388	1



SUFFIX	RESISTOR		RESISTOR		RESISTOR	
	R49	VALUE OHMS	R50	VALUE OHMS	R51	VALUE OHMS
-1601	J735552-0379	8.06K	J735552-0498	140K	J735552-0563	665K
-1602	J735552-1333	2.67K	J735552-0466	64.9K	J735552-0571	806K

NOTES:

4. CONFORMAL COAT FINAL ASSEMBLY PER PT-9368-1 (SPRAYCOAT), USING THE FOLLOWING PRECAUTIONS :
   A) MASK CONNECTOR CONTACTS FOR J1 AND J2 USING MASKING MATERIAL THAT LEAVES NO RESIDUE.
   B) PROTECT LED'S AND POTENTIOMETER
   C) MASK GROUNDING PAD LOCATED NEAR R37.

6. POLARIZED PART OUTLINE SHOWN BELOW:
   [ ] ← CHAMFERED EDGE DENOTES POSITIVE END OF CAPACIITORS AND CATHODE END OF DIODES.

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Figure A-16 - EOT Marker Light NiCAD Type SBU PCB - PN: N4519231601
Lead-Acid Type SBU - PN: N4519231602

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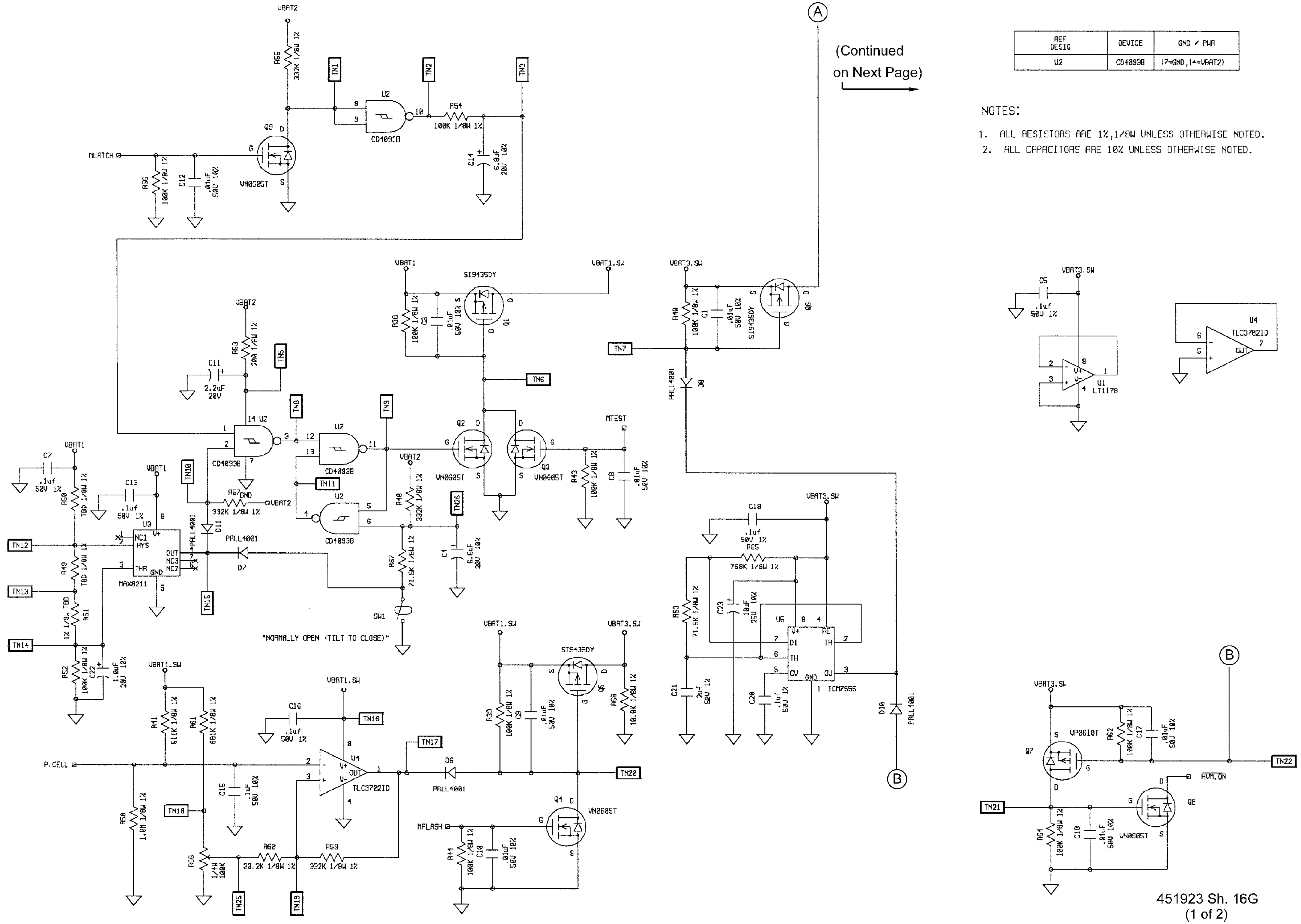
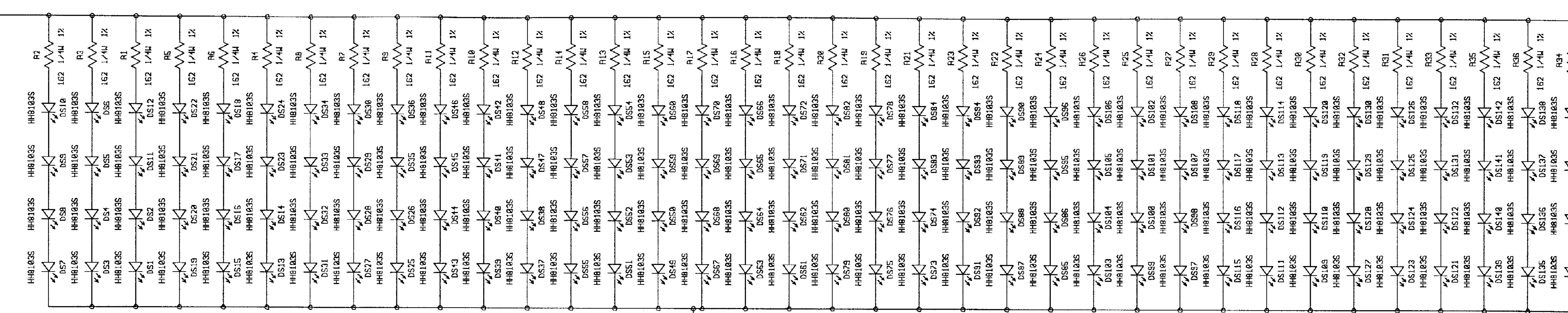
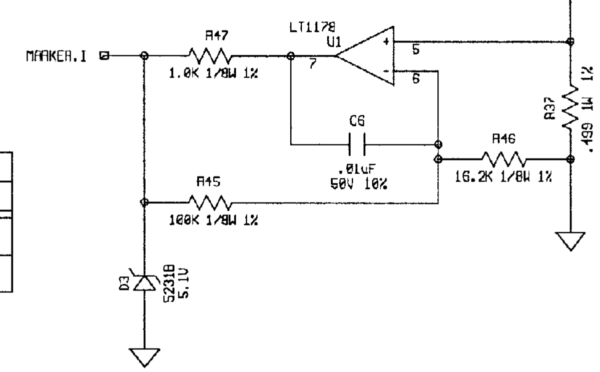


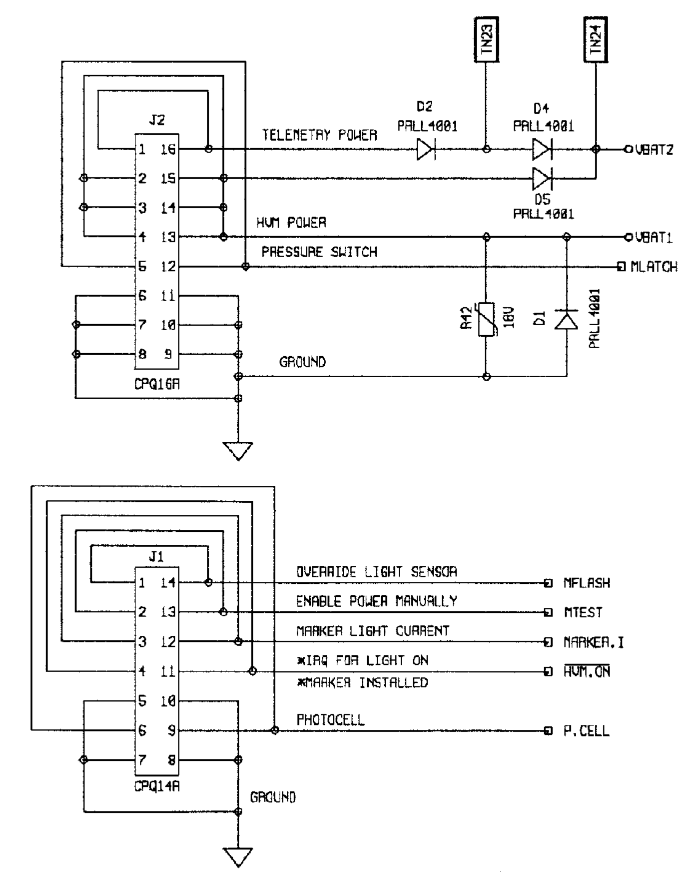
Figure A-17 - EOT Marker Light Schematic NiCad Type SBU PCB - PN: N4519231601, Lead-Acid Type SBU - PN: N4519231602

(Continued from previous Page)





SUFFIX	RESISTOR		RESISTOR		RESISTOR	
	R49	VALUE OHM	R50	VALUE OHM	R51	VALUE OHM
-1601	J735552-0379	8.06K	J735552-0498	140K	J735552-0568	665K
-1602	J735552-1333	2.67K	J735552-1466	64.9K	J735552-1571	806K

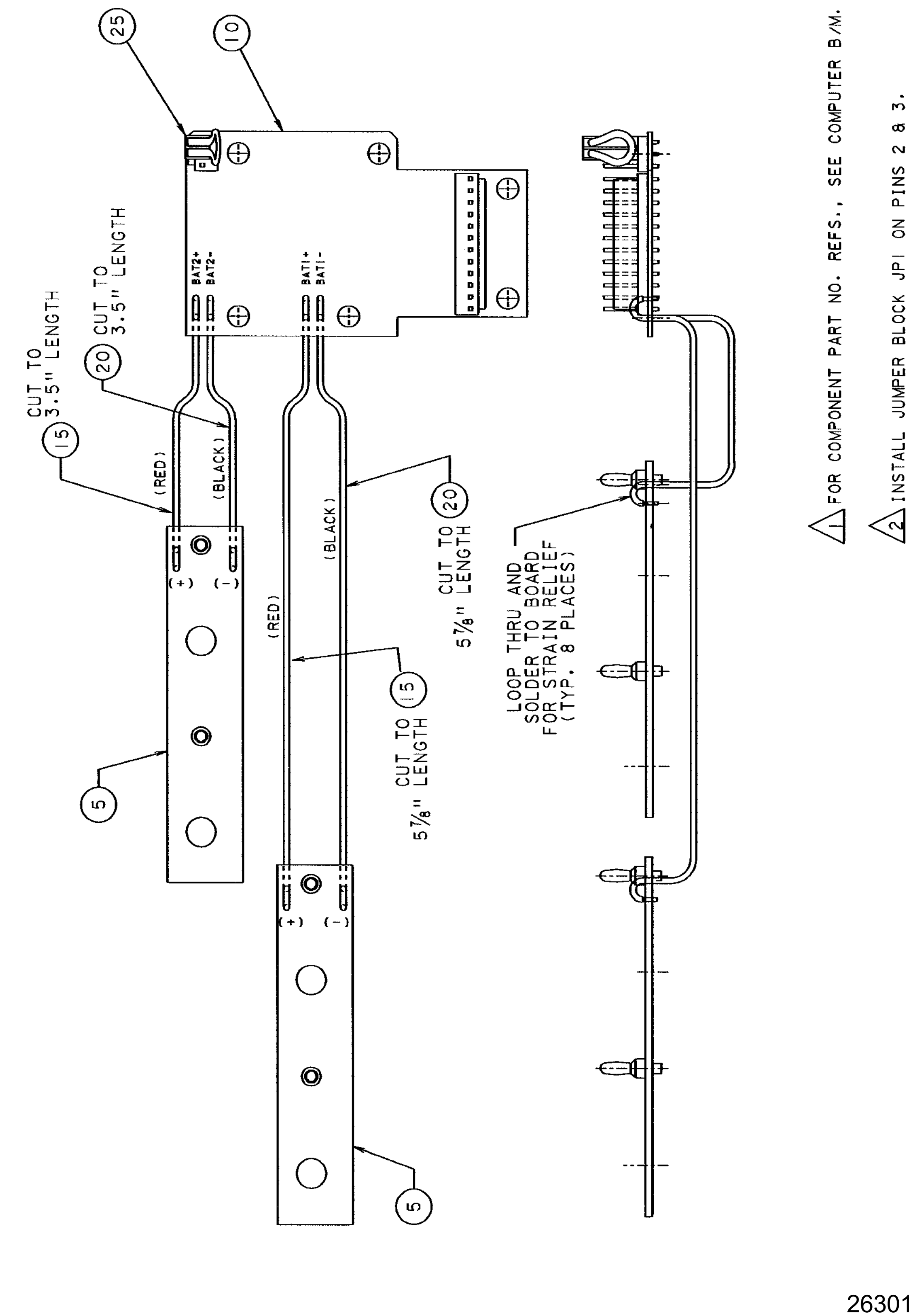


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(2 of 2)

Figure A-17 (Continued) - EOT Marker Light Schematic NiCad Type SBU PCB - PN: N4519231601, Lead-Acid Type SBU - PN: N4519231602

A.33 ASSEMBLY, BATTERY/INTERFACE EOT (PN: N26301301)

Item No.	Description	Part Number	Quantity per Assembly
5	PCB, EOT Battery	N4519233501	2
10	PCB, EOT Interface	N4519233401	1
15	W-18 Awg Tefzel Red	A0458520006	1
20	W-18 Awg Tefzel Black	A0458520000	1
25	Jumper Assy .156”	N24604402	1



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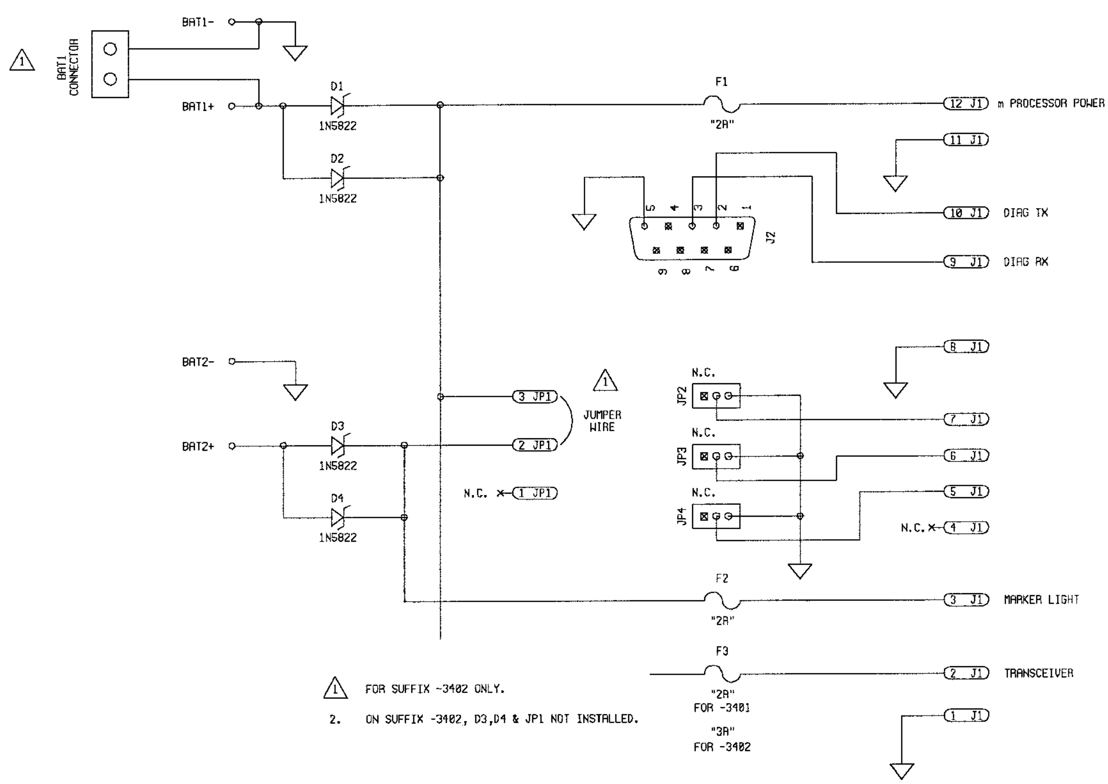
Figure A-18 - Battery/Interface EOT Assembly - PN: N26301301

A.34 PCB, EOT INTERFACE NICAD TYPE SBU (PN: N4519233401)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC EOT Interface	J776616779	1
5	J2	Conn - DB9 Female	J7091460847	1
10	D1, D2, D3, D4	Diode - IN5822 Rect	J7261500173	4
15	JP1	Conn - Hdr 3 Pos	J7091460833	1
20	J1	Conn - Header 12 Pos	J7091460838	1
25	JP2. JP3, JP4	Strip - Cont Post 36	J7259120001	1
30	JP2. JP3, JP4	Jack, Shorting	J713343	3
40	F1, F2, F3	Fuse, 2 Amp 250 V	J710021	3
45	F1, F2, F3	Clip, Fuse PC Type 3AG	J576794	6
50	J2	Screw - 4-40 x 3/8 Pan Hd	J5072970106	2
55	J2	Washer - No 4 Flat SS	J4751200106	2
60	J2	Washer - SST Lock No 4	J4751210105	2

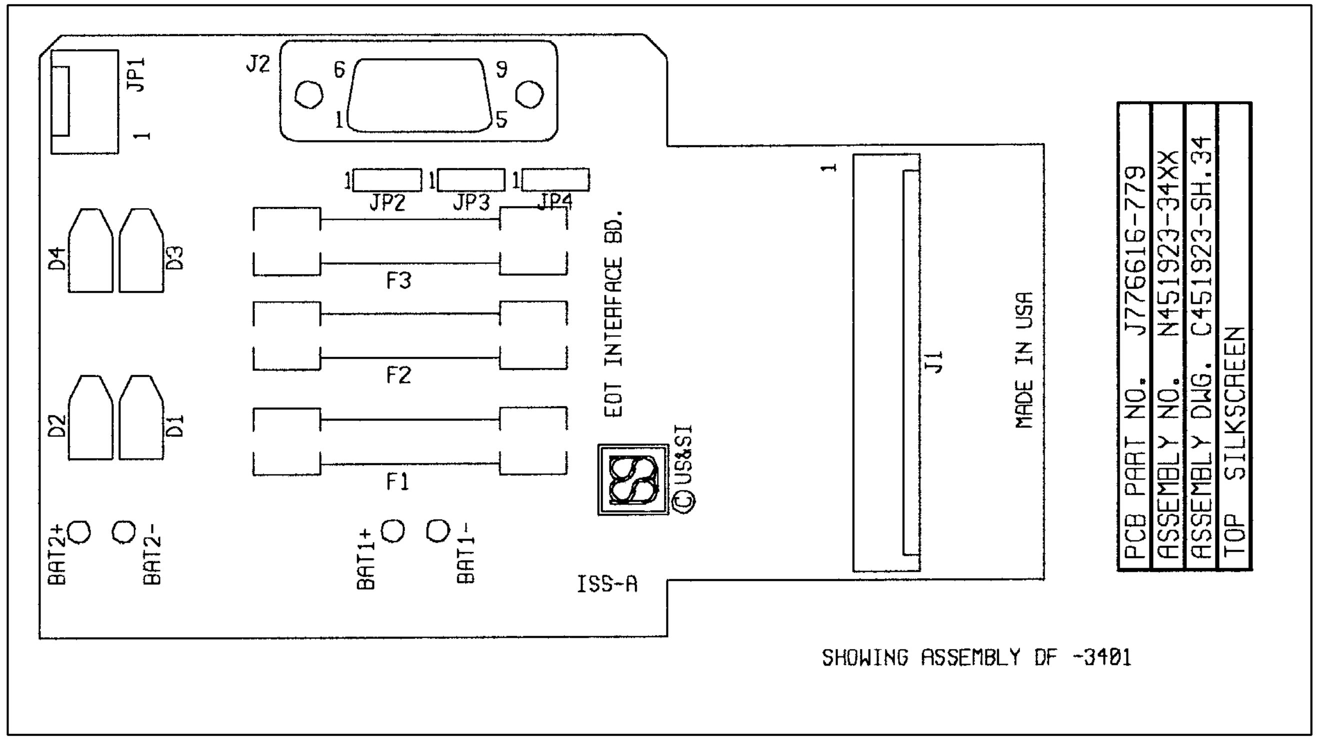
A.35 PCB, EOT INTERFACE, LEAD-ACID BATTERY SBU (PN: N4519233402)

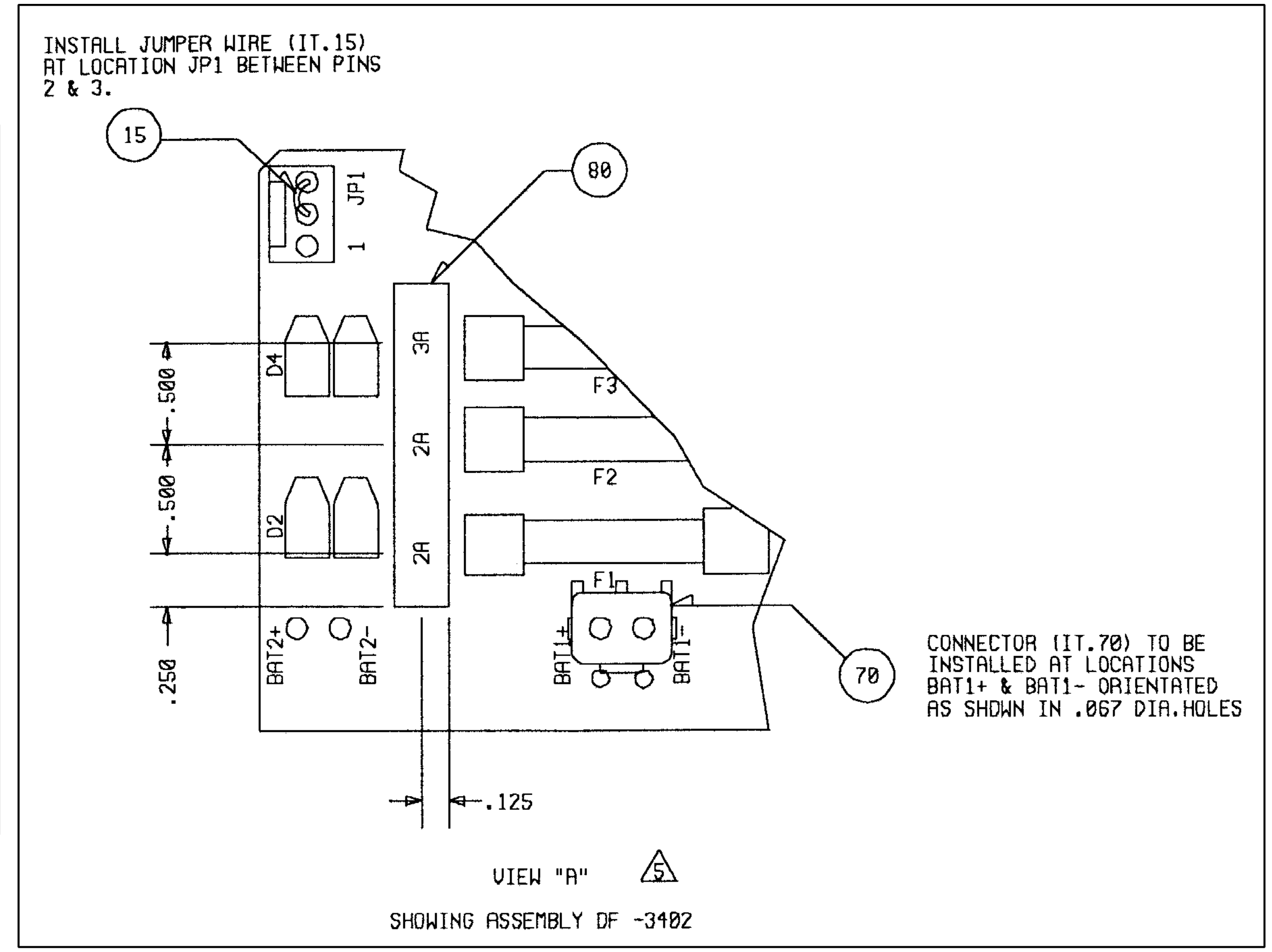
Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC EOT Interface	J776616779	1
5	J2	Conn - DB9 Female	J7091460847	1
10	D1, D2,	Diode - IN5822 Rect	J7261500173	4
15	JP1	W-22 Bare Tinned Cop	A043183	.083
20	J1	Conn - Header 12 Pos	J7091460838	1
25	JP2. JP3, JP4	Strip - Cont Post 36	J7259120001	1
30	JP2. JP3, JP4	Jack, Shorting	J713343	3
35		Brd-PC EOT Interface	J776616779	1
40	F1, F2, F3	Fuse, 2 Amp 250 V	J710021	3
45	F1, F2, F3	Clip, Fuse PC Type 3AG	J576794	6
50	J2	Screw - 4-40 x 3/8 Pan Hd	J5072970106	2
55	J2	Washer - No 4 Flat SS	J4751200106	2
60	J2	Washer - SST Lock No 4	J4751210105	2
65	F3	Fuse, 3 Amp 250 V	J710090	1
70	Bat1	Header - PC Brd Mnt 350539-2	J7091460947	1
75	--	Label	J075962	1
80	--	Label-Datab	J0759550004	1



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Figure A-19 - EOT Interface NiCAD Type SBU PCB - PN: N4519233401
Lead-Acid Battery SBU - PN: N4519233402





5. -3402 TO BE ASSEMBLED PER VIEW "A".

6. ON -3402, COMPONENTS JP1, D3 & D4 NOT INSTALLED.

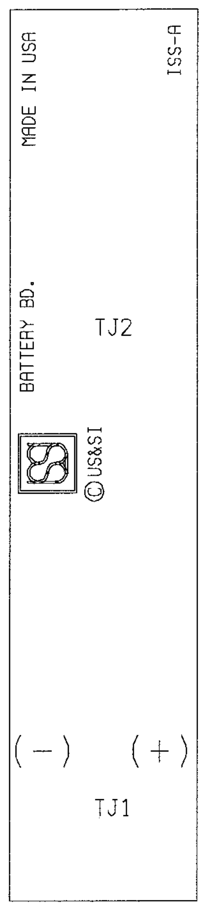
7. INSTALL JUMPER BLOCKS JP2 ON PINS 2 AND 3.
   INSTALL JUMPER BLOCKS JP3 AND JP4 ON PINS 1 AND 2.

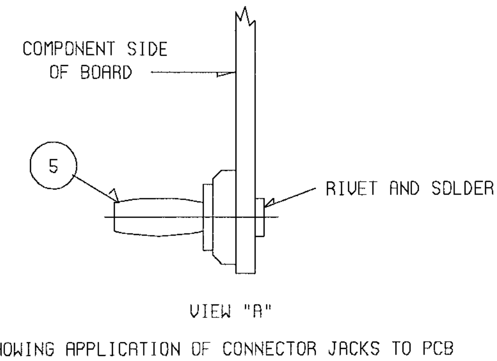
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Figure A-19 (Continued) - EOT Interface NiCAD Type SBU PCB - PN: N4519233401
Lead-Acid Battery SBU - PN: N4519233402

A.36 PCB, EOT BATTERY (PN: N4519233501)

Item No.	Reference Designator	Description	Part Number	Quantity per Assembly
0	--	Brd - PC EOT Battery	J776616780	1
5	TJ1, TJ2	Jack, For Stu Battery, 6621	306-0036-00	2





1. FOR COMPONENT PART NUMBER REFS, SEE COMPUTER BM.

3. INSTALL CONNECTOR JACKS (IT.5) PER VIEW "A".

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Figure A-20 - EOT Battery PCB - PN: N4519233501